SCIENCE

VOL. 103 | *Friday, June 28, 1946* | NO. 2687

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The War and Biological Sciences in Japan

J. Linsley Gressitt

Published by the

American Association for the Advancement of Science

SCIENCE

Editor: Willard L. Valentine

Assistant Editor: Mildred Atwood *Advertising Manager:* Theo. J. Christensen

Policy Committee: Malcolm H. Soule, Roger Adams, Walter R. Miles and Kirtley F. Mather

VOL. 103 FRIDAY, JUNE 28, 1946 No. 2687

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SCIENCE: A Weekly Journal, since 1900 the official organ of the American Association for the Advancement of Science. Published by the American Association for the Advancement of Science every Friday at Lancaster, Pennsylvania.

Communications relative to articles offered for publication should be addressed to Editor, Massachusetts and Nebraska Avenues, Washington 16, D. C.

Communications relative to advertising should be addressed to THEO. J. CHRISTENSEN, Massachusetts and Nebraska Avenues, Washington 16, D. C.

Communications relative to membership in the Association and to all matters of business of the Association should be addressed to the Permanent Secretary, A.A.A.S., Smithsonian Institution Building, Washington 25, D. C.

Annual subscription, $6.00 Single copies, 15 cents

Entered as second-class matter July 18, 1923 at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

SCIENCE

Vol. 103, No. 2687 Friday, June 28, 1946

The Multiple Factor Theory of the Control of Respiratory Ventilation

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DURING THE PAST FIFTY YEARS a number of theories concerning the regulation of the respiratory minute-volume have been proposed. Although none of these theories has met with universal acceptance and none has been amenable to quantitative expression, it is of interest to review briefly their development as an introduction and background to the theory herein proposed.

The various theories proposed up to 1925 have one characteristic in common: they place respiratory ventilation under the control of a unique chemical agent whose effective concentration is located in the arterial blood. In the order of their proposal, these theories attribute the control of ventilation to the arterial oxygen tension, the arterial carbon dioxide tension, and the arterial hydrogen-ion concentration (*3, 10, 13*). There are, however, insurmountable objections to each of these theories. For example, the arterial pO_2 theory explains the respiratory response to anoxia, but affords no explanation of the respiratory responses to exercise, acidosis, alkalosis, or carbon dioxide inhalation, for there are no appropriate changes in the arterial pO_2 in any of these conditions. Similarly, the arterial pCO_2 theory explains the respiratory response to the inhalation of carbon dioxide, but provides no explanation for the changes in ventilation which accompany exercise, acidosis, alkalosis, or anoxia, for in all these conditions the alterations in arterial pCO_2 are in the wrong direction. Finally, the arterial H-ion theory explains the respiratory changes in metabolic acidosis and alkalosis, but fails to explain the responses in exercise, anoxia, or carbon dioxide inhalation; in anoxia the arterial H-ion concentration moves in the wrong direction, and in exercise and carbon dioxide inhalation the changes, although in the right direction, are wholly inadequate in degree. In summary, each of these theories merely restates the single phenomenon upon which it is based and fails completely to provide any understanding of other equally important phenomena.

The above conclusion, expressed forcefully and in some detail by Gesell in 1925 (*3*), provided the point of departure for new approaches to the problem of the regulation of respiration. Theoretically, there are at least three ways in which the difficulties of the above theories may be avoided.

(a) The principle that a unique chemical agent in the arterial blood is the only "true" stimulus to the respiratory center may be retained, but extended by assuming that final control of respiration depends upon variations in the irritability of the respiratory center towards this unique agent. Nielsen's (*13*) theory is an example of the application of this alternative.

(b) The principle may be retained that respiration is controlled by a unique chemical agent, but its effective concentration may be located elsewhere than in the arterial blood. Gesell's (*3*) theory is an example of the application of this alternative.

(c) The principle of a unique chemical agent may be rejected and replaced by the principle that a number of agents exert independent effects upon respiration and that the net ventilation under any given condition is determined by the sum of the partial effects of the separate agents. This alternative is the basis of the present multiple factory theory.

It is profitable to analyze examples of the first two alternatives. Nielsen's theory states (a) that carbon dioxide is the unique stimulus for the respiratory center, and (b) that the respiratory responses to exercise, acidosis, and anoxia are mediated by increased irritability of the respiratory center to the diminished CO_2 level. The first of these tenets is mistakenly based upon the experimental observation that CO_2 elicits a greater respiratory response per unit change in pH than other acids. The actual observation of responses to both stimuli denies Nielsen's conclusion of *unique* potency of one of them. The

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second tenet follows inevitably from the first, for, if CO_2 is the unique stimulus, and if, as Nielsen so nicely demonstrated, the CO_2 level is decreased in anoxia, acidosis, and exercise, one is compelled to interpret the accompanying respiratory responses as increased irritability to CO_2. In order to provide proof for such changes in irritability, he plotted the relationship between alveolar pCO_2 and ventilation in subjects breathing various percentages of carbon dioxide under conditions of rest, exercise, anoxia, and ammonium chloride acidosis. The resulting curves in the different conditions proved to be linear with the same slopes but with significantly different positions. The constant slopes reveal that a given increment in stimulus produces the same increment in response regardless of the conditions: this is evidence of unaltered irritability. The simple change in position suggests the influence of an additional factor, operating independently of CO_2. The two essential tenets of Nielsen's theory are therefore without experimental foundation. In spite of the fact that the theory considers carbon dioxide to be the only "true" stimulus to the respiratory center itself, it does introduce the notion that a number of factors are involved in the final control of respiration.

Gesell's original theory (*3*) stated that respiratory ventilation is controlled by the H-ion concentration within the respiratory center itself. This theory also preserved the principle of a unique respiratory stimulus and at the same time avoided the objections to the arterial H-ion theory. The improvement, however, is more apparent than real, for the H-ion concentration of the cells of the respiratory center is still beyond measurement. Nevertheless, the theory did emphasize the possible consequences of a lack of parallelism between arterial and cellular concentrations of stimulating agents, which may occur in transitory disequilibrium states, and in conditions of markedly altered blood flow.

With the discovery of the role of chemoreceptors in the carotid and aortic bodies, Gesell modified his theory to include indirect activation of the center through outlying sensory receptors (*4*). Furthermore, oxidation processes as well as H-ion concentrations within the cells are considered important in the activation of sensory receptors, both central and peripheral. This modified theory is no longer primarily a theory of the over-all regulation of respiration; rather, it is primarily a theory concerning the intracellular mechanisms by means of which certain agents, involved in the control of respiration, bring about stimulation or activation of receptor and effector cells. The two types of theory, however, are neither mutually exclusive nor competitive, but complementary.

The Multiple Factor Theory

The preceding theories for the most part may be called single factor theories, for they embody the principle of a unique stimulus for respiration or for the respiratory center. The fact that such theories have so consistently met with failure suggests a closer scrutiny of the principle of a unique stimulus. As a matter of fact, the poverty of direct evidence in favor of this principle stands in contrast to the wealth of homely evidence in favor of the opposite principle, that numerous factors influence respiration. The possibility that respiration is controlled by the integrated action of a number of factors has been repeatedly suggested, among others by Yandell (*12*) and Lawrence (*11*) Henderson and Bernthal (*1*) and more recently by Comroe (*2*). In fact, if Nielsen's theory (*13*) is divested of its postulates concerning a "true" stimulus and its site of action, it becomes a multiple factor theory. However, no one appears to have pursued this principle to its logical conclusions and to have attempted to apply it in a quantitative fashion. The present multiple factor theory is an attempt to do this.

In formulating the multiple factor theory it is important to distinguish clearly between the over-all regulation of respiration for homeostatic purposes and the intimate cellular mechanisms involved. The present theory is an attempt to describe quantitatively the integrated action of the various factors which control respiration, regardless of their sites of action or mechanisms. Like thermodynamics, it is concerned with the beginnings and ends of processes and not with the intervening steps, however important the latter may be from other standpoints. Since the multiple factor theory does not specify the site or mode of action of the various factors concerned, it will not stand or fall as a result of new developments along these lines. It should, in fact, serve as a useful guide in formulating and interpreting experiments designed to elucidate such mechanisms.

The multiple factor theory is based upon three fundamental principles, the first of which may now be stated explicitly. *The multiple factor principle states that a number of factors exert independent effects upon respiratory ventilation.*

The first step in the application of the multiple factor principle is to attempt to identify the various factors concerned. Since the administration of fixed acid, the inhalation of CO_2, and the withdrawal of O_2 result in increased ventilation, it is proper to consider these three chemical agents as possible factors. The recent demonstration that reflexes arising in exercising muscles bring about an increase in ventilation suggests an additional factor to be considered. The

list should also include pressoreceptor reflexes from the great arteries and great veins; thermoreceptor reflexes, presumably from the hypothalamus; and finally, pain reflexes and psychogenic reflexes. Of the above factors, the four most important ones, at present, appear to be three chemical agents and the muscle reflexes.

The second step in the application of the multiple factor principle is to decide at what point the concentrations of the three chemical agents are to be measured. Although ideally their concentrations should be measured in the respiratory center and the peripheral chemoreceptors where they exert their effects, this is not feasible. Venous blood levels are unsuitable because of the extreme variability in the composition of venous blood. Neither mixed venous blood nor blood from any accessible vein reliably reflects conditions both within the respiratory center and in outlying chemoreceptors. The only remaining possibility is arterial blood. There are also positive reasons which favor this choice. First, the chemoreceptors of the carotid and aortic bodies are believed to be exposed to arterial blood. In addition, parallelism between concentrations in arterial blood and in the respiratory center is promoted by the carefully regulated cerebral circulation. Finally, external respiration directly controls the gaseous composition of arterial blood. Accordingly, the most feasible approach is to correlate respiratory ventilation with the arterial concentration of the three chemical agents, bearing in mind the possibility that difficulties may arise in transitory unsteady states and in conditions of seriously altered blood flow.

It should be made clear that the multiple factor principle does not require that the partial effects of the separate agents be quantitatively fixed and invariable. The respiratory mechanism may, for example, be depressed by narcotic drugs and fail to exhibit a normal responsiveness to one or more of the respiratory factors. Such changes in sensitivity, however, should be demonstrated as an alteration in the slope of the stimulus-response curve of the partial factors in question.

A study of the behavior of the several agents selected above reveals that they are interrelated. Although, in accordance with the multiple factor principle, they may be considered to exert independent partial effects on ventilation, *they are not independent of one another.* It is well known, for example, that the arterial O_2 tension, CO_2 tension, and H-ion concentration are all elevated by the inhalation of CO_2 and depressed by the inhalation of air deficient in O_2, although in both instances ventilation is increased. It is known further that the increase in ventilation resulting from the administration of acidifying salts is accompanied by an increase in arterial O_2 tension and H-ion concentration and a fall in CO_2 tension. Finally, any reflex which increases ventilation without a corresponding increase in CO_2 production by the body as a whole will lead to acapnia and alkalemia. It is therefore apparent that the various respiratory agents influence one another to such an extent that a change in one agent alone rarely occurs either physiologically or pathologically. These observations provide the basis for the second principle of the multiple factor theory. *The interdependence principle states that a change in any one of the respiratory factors usually brings about changes in one or more of the other factors.*

If it is true that under most circumstances several factors are exerting independent but simultaneous influence on respiration, some method of combining the separate effects to represent the total effect must be adopted. The simplest device is to take the algebraic sum of the partial, or separate, effects to yield the total or combined effect. The necessity of specifying the algebraic sum arises from the fact that certain of the chemical agents are capable of inhibiting respiration, a situation represented by a negative partial effect. The total ventilation, of course, can never be negative, but the partial effect of an inhibitory agent may be considered negative. This flexibility and simplicity of the algebraic summation principle favors its adoption over that of a more complex device, such as taking the product of partial effects, which would imply synergistic action of the agents. The latter procedure should be avoided until actual evidence of synergism is encountered. This brings us to the third principle of the multiple factor theory. *The algebraic summation principle states that the actual ventilation is defined as the algebraic sum of the partial effects of the separate agents.*

It follows from the above principles that several types of effects on respiration must be carefully distinguished. A partial effect is the effect of a single agent when all other agents are kept constant. The actual ventilation rarely, if ever, represents a single partial effect. If all the partial factors are operating in the same direction, the actual ventilation represents an *additive* effect; if in opposite directions, a *difference* effect.

For the multiple factor theory to be successful as a theory it must be possible (a) to isolate and quantify the partial effects on ventilation of each of the important factors concerned, (b) to quantify the interrelationships between the various factors concerned, and (c) to demonstrate that algebraic summation of these partial effects does correctly predict the actual ventilation under various conditions.

During the past several years considerable progress

has been made in completing the above phases in the quantitative development of the theory. The first step consisted of the derivation on formal grounds of what has been called the alveolar equation (*5, 8*), which defines all possible relationships between alveolar (or arterial, since the two have been shown to be in equilibrium) O_2 and CO_2 tensions for any barometric pressure, alveolar RQ, and for any inspired gas mixture. This equation, like the others presented in Table 1, is fairly complex in its most general form, but happily reduces to much simpler forms for specific applications.

TABLE 1

EQUATIONS AND MATHEMATICAL SYMBOLS

1. The general alveolar equation (relationship between pO_2 and pCO_2) :

$$pO_2 = \frac{(B\text{-}47 - pCO_2)(RQ \cdot FO_2 + FCO_2) - pCO_2(1\text{-}FO_2(1\text{-}RQ))}{RQ + FCO_2(1\text{-}RQ)}$$

2. The general formal ventilation equation (relationships between actual ventilation and pCO_2) :

$$VR = \frac{47\ MRR(RQ + FCO_2(1\text{-}RQ))}{pCO_2 - (B\text{-}47)\ FCO_2}$$

3. The general respiratory pathway equation (relationships between H-ion and pCO_2) :

$$pCO_2 = \frac{H}{53.3}[(16 + 2.3\ O_{2_{150}})\ (\log H - 1.59) + BHCO_{3_{7.41}} + 0.375(O_{2_{150}} - O_2)]$$

4. The chemical ventilation equation (giving the sum of the partial effects of H-ion, pO_2, and pCO_2 on ventilation) :

$$VR = 0.22H + 0.262\ pCO_2 - 18.0 + \frac{105}{10^{0.038pO_2}}$$

pO_2, pCO_2 = alveolar or arterial tensions of O_2 and CO_2, respectively
FO_2, FCO_2 = volumetric fractions of O_2 and CO_2 in dry inspired air, respectively
B = barometric pressure
RQ = alveolar respiratory quotient
VR = alveolar ventilation ratio (excluding dead space ventilation) expressed as the ratio of actual alveolar ventilation to resting alveolar ventilation
$VRpo_2$, $VRpco_2$, VR_H = alveolar ventilation ratio as it is influenced solely by the factor or factors identified in the subscript, all other factors remaining constant; partial ventilation ratio
VR_R = partial ventilation ratio due to action of muscle reflexes
H = H-ion concentration of arterial plasma; $pH = -\log H + 9$
$BHCO_{3_{7.41}}$ = bicarbonate content in vols. per cent of plasma from oxygenated blood at a pH of 7.41
O_2 = oxygen content of blood in vols. per cent
$O_{2_{150}}$ = oxygen capacity of blood in vols. per cent expressed as O_2 content of blood exposed to a pO_2 of about 150 mm. Hg
MRR = metabolic rate ratio, expressed as the ratio of the actual metabolic rate to the resting rate

The second step consisted of an analogous derivation on formal grounds of what has been termed the formal ventilation equation (*8*), which defines the possible relationships between the actual ventilation and the alveolar CO_2 tension for any condition of metabolic rate, alveolar RQ, and inspired gas mixtures.

The third step consisted of developing on empirical grounds what has been called the respiratory pathway equation (*9*), which defines the possible relationships between the arterial H-ion concentration and CO_2 tension, for any conditions of bicarbonate capacity, O_2 capacity, and arterial O_2 saturation.

The fourth and latest step to be completed consists of the isolation and quantification of the partial effects on ventilation of the three important chemical agents, H-ion, pCO_2, and pO_2. The partial effects of H-ion and pCO_2 were established empirically on the basis of extensive data available in the literature on the composition of blood in both respiratory and metabolic disturbance of acid-base balance. The partial effect of pO_2 was similarly established on the basis of extensive data (*6*), on the composition of alveolar air in decompression anoxia. These separate partial effects may be summed to yield what has been identified as the chemical ventilation equation (*9*).

The variables VR, H, and pO_2 may be eliminated from the chemical ventilation equation by substitution of the previous three equations, thereby providing a quantitative description of the behavior of respiratory ventilation under any conditions where the three chemical agents, operating normally, are controlling ventilation.

One of the major achievements of the present theory is that it resolves the most persistent and controversial question in the field of respiration: Should H-ion or CO_2 be considered the true respiratory stimulus? From the standpoint of the multiple factor theory this question should be framed as follows: To what extent does each of the two agents influence ventilation? Equation 4, which accurately describes the extensive experimental data, provides a quantitative answer to this question. If it were true that only one of the two agents is the true stimulus, the procedure used to establish Equation 4 would have betrayed the fact by emerging with a coefficient of zero for the inactive agent. Since neither of the coefficients is zero, it must be concluded that both agents independently affect respiration.

The combined action of the two agents, H-ion concentration and pCO_2, is illustrated in Table 2 by data which were calculated from the equations presented above and which accurately describe experimental findings. The first line of the table represents the normal resting condition, and the next two lines represent respiratory and metabolic acidosis, respectively. In all three conditions the metabolic rate ratio is unity; although there are changes in O_2 tension, the range covered is an inactive one for this agent. The inhalation of 5 per cent CO_2 elevates both the CO_2 tension and the H-ion concentration. Since the partial effects of both agents are stimulatory, a vigorous respiratory response occurs, amounting to a 268 per cent increase over the resting value. This marked response to the inhalation of CO_2 is, of course, well known. By contrast, an identical increase in H-ion concentration due to a metabolic acidosis, induced by NH_4Cl or any fixed acid, results in a comparatively feeble respiratory response, amounting to only 9 per cent. The reason for this becomes

apparent from an examination of the behavior of the CO_2 tension. The increase in ventilation mediated by the acidemia leads to hypocapnia, which exerts an inhibitory partial effect (indicated by a negative sign in Table 2), which nearly neutralizes the partial effect of the acidemia. It is important to note that the partial effect of the H-ion is identical in both types of acidosis, indicating unaltered sensitivity, but that in one type its action is assisted by the accompanying hypercapnia and in the other it is hindered by the accompanying hypocapnia.

TABLE 2

Condition	Arterial pO_2	Arterial pCO_2	Arterial reaction		Metabolic rate ratio	Partial increments				Total ventilation ratio
			H-ion	pH		$VRpo_2$	$VRpco_2$	VR_H	VR_R	
Resting	104.1	40	38.9	7.410	1.00	...	...	...	...	1.00
5% CO_2 inhalation	140.8	46.7	43.1	7.336	1.00	0.00	1.75	0.93	0.00	3.68
NH_4Cl acidosis	107.8	36.8	43.1	7.336	1.00	0.00	−0.84	0.93	0.00	1.09
Anoxia, 12,170 ft.	49.0	36.8	36.6	7.436	1.00	1.44	−0.84	−0.51	0.00	1.09
Passive exercise	121.1	28.6	30.7	7.516	1.00	0.00	−2.99	−1.81	5.20	1.40
Active exercise	104.1	40.0	38.9	7.410	6.20	0.00	0.00	0.00	5.20	6.20

Study of these data in Table 2 leads to the conviction that any attempt to explain them in terms of only one of the two arterial agents is doomed to failure. If, nevertheless, one insists upon the existence of a unique stimulus, be it H-ion or pCO_2, one is then compelled to assume fortuitous alterations in responsiveness to this stimulus. All these objectionable features are avoided simply and logically by the multiple factor approach.

The fourth line of Table 2 illustrates the combined action of all three chemical agents in anoxia resulting from exposure to altitude. At 12,170 feet, breathing atmospheric air, the reduced O_2 tension, operating through the chemoreceptors, increases the respiratory minute-volume. This respiratory response leads to hypocapnia, which in turn produces an alkalemia. The final increase in ventilation, as is well known, is relatively small, amounting in this example to only 9 per cent. The reason for this small response is that the partial effects of both the hypocapnia and alkalemia are inhibitory and nearly neutralize the partial effect of the anoxic stimulus.

The lack of a satisfactory explanation of the intense respiratory response to exercise has been a serious deficiency of previous theories. Although analysis of this problem in terms of the multiple factor theory has not been completed, the usefulness of this approach may be indicated by the following preliminary analysis. It has recently been demonstrated that a purely reflex respiratory response occurs in passive exercise (*2*). Since the response, however, is so small in comparison to the response to active exercise, it has been considered to play a negligible role in active exercise. That this conclusion is wholly unjustified is indicated by the calculations presented in the last two lines of Table 2. It has been reported (*2*) that passive exercise of one leg in human subjects produces an average increase in ventilation of 40 per cent. If it can be assumed that the passive nature of the exercise prevents any change in metabolic rate, it can be calculated that a considerable hypocapnia and alkalemia must have resulted. Since the reflex increased ventilation against the marked inhibitory action of these changes, it must have been quite powerful—in fact, so powerful that, acting alone, it should increase ventilation by 520 per cent. When this reflex is operating under more normal conditions of active exercise, it should not meet with opposition, for the metabolic rate and CO_2 production should be increased. The last line of Table 2 shows that, granted a reflex of this same intensity in active exercise, it should be able to handle a 520 per cent increase in metabolism without any disturbances in gas transport, or disturbance in the levels of gas tensions or pH. Contrary to the original conclusion, this analysis implies that the muscle reflexes may play a major role in mediating the respiratory response to exercise. It further implies that the chemical agents play a minor role in this situation, an implication which certainly is in harmony with experimental observations on the behavior of these agents in exercise. It may be tentatively concluded that in exercise the chemical agents carried by the blood stream provide (a) a fine adjustment of ventilation, automatically brought into play when the reflex response is not otherwise exactly commensurate with the increased requirements for gas transport, and (b) the adjustment required as compensation for the metabolic acidosis of severe exercise.

The multiple factor theory has already proved its usefulness in the analysis of respiratory problems in aviation. It provides accurate estimates of O_2 requirements at various altitudes (*5*), of equivalent altitudes breathing various percentages of O_2 (*7*), and provides a basis for determining the effects of adding CO_2 to various gas mixtures at altitude (*8*). It has also afforded a quantitative description and explana-

tion of the mean pathways for disturbances of acid-base balance (*9*). It promises to reveal additional insight into acclimatization to altitude and into the various stages of compensation to acid-base balance disturbances.

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Technical Papers

Radioactivation of Colloidal Gamma Ferric Oxide

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Welo and Baudisch (*7*) were the first conclusively to establish that ferric oxide—Fe_2O_3—exists in both a cubic and a rhombohedral form. The cubic form, γ ferric oxide, is the labile one and ages slowly, under loss of energy, into the stable rhombohedral form, the common α Fe_2O_3 or hematite. The cubic or spinel type, γ Fe_2O_3, possesses magnetic properties similar to, but feebler than, metallic iron and, in addition, a remarkable number of catalytic and biocatalytic qualities. The rhombohedral, α Fe_2O_3, which is not magnetic, is also active in a biocatalytic manner but to a lesser degree than the cubic form.

It is obvious that the difference in physical behavior of the two chemically identical modifications of iron oxide must be attributed to the difference in their crystal structure. Many investigators have studied the crystal structure of these iron oxides (*6*). The result of these investigations was the discovery that the lattice in the structure of γ Fe_2O_3 is incomplete. The lattice of γ Fe_2O_3 contains so-called "interstitial spaces" (atomic holes) which, in the more stable lattice of α Fe_2O_3, are filled up by ferric ions. The elemental crystal of γ Fe_2O_3 contains an average of $21\frac{1}{3}$ ferric ions compared to an average of 24 found in the crystal of α Fe_2O_3. This was ascertained mainly by a number of experiments dealing with the diffusion of liquids and gases in these crystals. It was found, for instance, that radium emanation diffuses freely through the "atomic holes" in γ Fe_2O_3 crystals, while α Fe_2O_3 is almost impenetrable to this emanation; in this case, the "atomic holes" are blocked at room temperature. The diameter of these "atomic holes" or channels in γ Fe_2O_3 ranges between 5.2 A. and 7.5 A., as the benzene molecule (diameter, 5.2 A.) may penetrate the crystal, but the xylene molecule (diameter, 7.5 A.) is unable to do so.

The fact that the cubic, ferromagnetic iron oxide possesses these "atomic holes" is of great significance, since within the crystal a secondary structure, or "inner surface" is formed. The comparatively great surface of this crystal is mainly responsible for the high catalytic reactivity of the material. Also, the "atomic holes" create electric disturbances within the crystal which may also influence the reactivity of the compound.

The properties of γ Fe_2O_3 remain unchanged when put into a colloidal state (*1*), and it is in this form that it is especially suitable for certain biological purposes. Colloidal solutions were prepared with a colloid mill, using as a carrying medium dextrin, olive oil, and gum arabic; the particle size obtained was 10^{-5} cm. or smaller.

Gamma ferric oxide in colloidal form may be injected directly into the blood stream. Peyton and Beard (*5*) found that the colloidal particles of γ Fe_2O_3 are taken out of the blood stream by the reticulo-endothelial cells, which are phagocytic to foreign materials of this type. These authors first isolated Kupffer's cells (reticulo-endothelial cells of the liver) by passing a sodium chloride solution through the liver and then using an electromagnet to separate the cells, the latter having been transformed into living magnets by the absorption of colloidal γ Fe_2O_3 particles. These reticulo-endothelial cells are distributed throughout the body, but are most abundant in the liver, spleen, and bone marrow. They

play an important role in the case of chronic inflammations, in the repair stage of acute processes, and in blood diseases. Colloidal gamma iron oxide has no toxic effects on the living cells; the cells proliferate and, after some time, have eliminated and are entirely free of all the iron particles.

It is easily seen that the reticulo-endothelial cells in the body can be influenced and their antibody actions stimulated if the colloidal γ Fe_2O_3 particles are combined with some therapeutically acting material, such as certain radioactive substances. A method of doing this is the main subject of the present article.

Experimental Evidence

It was first thought that radon gas (radium emanation) might be used as the radioactive substance with which to activate the colloidal γ Fe_2O_3 particles, but this proved to be impractical, since radon cannot be stored in this type of crystal because of the "atomic holes" in the lattice (which are responsible for the good qualities of γ Fe_2O_3 as an emanator). The idea of using radium itself as the activating material had to be discarded, as injections with Ra are not permissible. This also was the objection to the use of polonium, which is highly toxic unless used in infinitesimal quantities.

It was therefore necessary to look elsewhere for a radioactive substance which would be an alpha radiator, which could be deposited easily and firmly on and within γ Fe_2O_3, and which had a short half-life in order to avoid dangerous aftereffects.

The active deposits of radon—Ra A, Ra B, and Ra C—were finally chosen as activators. Ra A is an alpha-ray emitter with such a short half-life (3.05 minutes) that its activity, in this case, is negligible; Ra B, with a half-life of 26.8 minutes, is a beta- and gamma-ray emitter; and Ra C, with a half-life of 19.7 minutes, is the most potent alpha and gamma radiator in the radium series. Depositing Ra A, Ra B, and Ra C in equilibrium conditions onto another substance, Ra C (the substance in which we are predominantly interested for our experiments), would decay approximately with the half-life period of Ra B.[1]

Experiments were then made with the object of finding a suitable method of deposition of the radioactivating substances on and within the colloidal γ Fe_2O_3. Generally, activations with the active deposits of Ra emanation are done by an electrical method. The substance to be activated is exposed to the emanation in an electrical field, in which the substance itself has to serve as the negative electrode. This method, although feasible in our case because of the metallic properties (conductivity) of iron oxide, which means that it could be used directly as the negative pole, was not employed, because the yield of such an exposure is small and the active deposit does not adhere very firmly. In addition to the preceding objections, it would only be possible to activate the surface layer of the exposed colloidal powder, an area which would be entirely insufficient in our case.

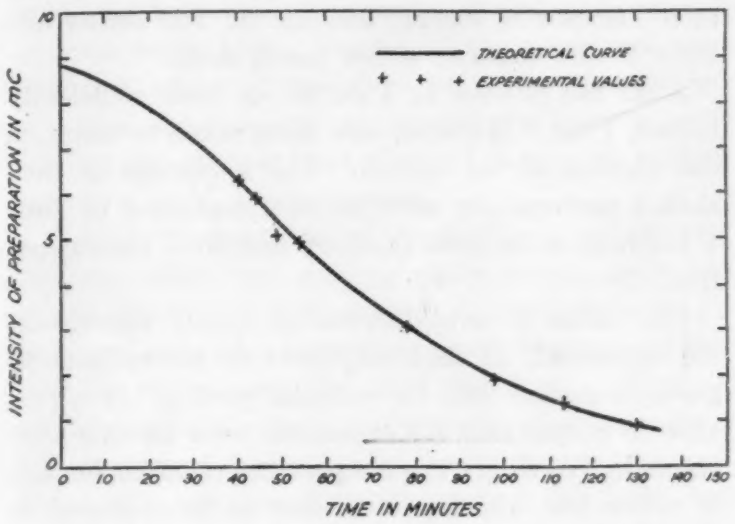

Fig. 1

For the above reasons another method of activation, similar to that first used by H. Petterson (*4*) for the activation of metallic disks, was adopted.

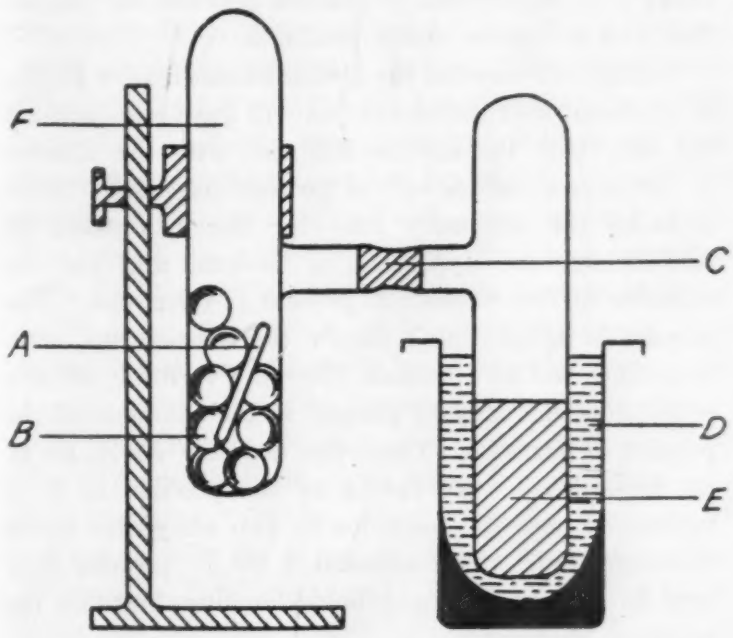

Fig. 2. A—glass capillary enclosing Ra emanation; B—metal shot; C—filter; D—liquid air; E—colloidal γ Fe_2O_3.

The pyrex glass apparatus shown in Fig. 2 was used for the activation of our compound. Into Tube E a small quantity (approximately 5 grams) of colloidal γ Fe_2O_3 powder was introduced, and the top of the tube sealed hermetically. The powder was then heated to about 150° C. while evacuating the apparatus through Tube F, in order to eliminate all possible gases that may have been absorbed in the powder and

[1] Ra C is formed by the decay of the longer-life product, Ra B, and will disappear approximately with the decay of Ra B.

which might clog the atomic channels within the crystals. Care was taken to keep the temperature at 150° C., since too high a temperature would result in the transformation from gamma to alpha iron oxide. This too may be controlled by testing the colloidal material for its magnetic properties (absent in α Fe_2O_3) after the initial heating.

Tube F contains a thin glass capillary which in turn encloses a known amount of Ra emanation. Tube F also contains a few metal shots.

After the powder in Tube E has been sufficiently heated, Tube F is sealed, care being taken to maintain the vacuum in the system. The apparatus is then shaken mechanically until the shot contained in Tube F has broken the glass capillary and freed the emanation.

The radon is now distributed equally throughout the apparatus, so that only part of the radioactive gas is in contact with the colloidal powder. It is possible to concentrate Ra emanation onto another substance by freezing. The temperature required for this is rather low, and liquid air had to be employed as a cooling agent. The part of Tube E containing the colloidal γ Fe_2O_3 was immersed in liquid air so that the radon might freeze upon the powder. The emanation concentrated in this manner has to remain in contact with the powder for three and one-half to four hours until equilibrium is reached between the emanation and its active decay products.

Taking into account the atomic channels of γ Fe_2O_3, it is evident that the emanation will have close contact not only with the surface but also with the interior of the crystal lattice of the powder particles. After allowing the necessary time for the attainment of equilibrium, the apparatus is broken, and the remainder of the emanation present is discarded. The powder is again heated (again the temperature is to be maintained at less than 150° C.) to drive off any emanation that may be present in the channels of the powder or particles. The active deposit—Ra A, Ra B, Ra C—adheres very firmly to the powder as it is hammered onto the particles by two successive alpha disintegrations. The colloidal γ Fe_2O_3 powder may now be dispersed in any liquid medium suitable for injection therapy.

In order to establish a definite method of dosage, the activity of the powder has to be measured before injection. Taking these measurements at different time intervals assures that we are really dealing with Ra B and Ra C and provides a definite check as to whether or not all the emanation is evaporated from the powder.[2] How completely this purpose was accomplished may be seen from the points plotted on the decay curve of Ra C (Fig. 1). The points on the curve correspond to the values of Ra C obtained when measured by its gamma radiation. The curve was drawn in accordance with the theoretical values for the decay of Ra B–Ra C after four hours exposure in decaying radon. The starting point of the curve and the absolute values of the ordinates are extrapolated from experimental values for the moment at which the emanation was discarded. The fact that all the experimental points are very close to the curve proves that no radon remained in the colloidal powder and that the extrapolation to the zero point is correct. This zero point, which gives the activity of Ra B–Ra C reached by the exposure in radon, is a measure for the yield of the above process of activation.

Various other experiments, using γ Fe_2O_3 of different particle sizes, were made with the result that the best yield was obtained, as expected, with the material in colloidal state. Without taking any special precautions, a yield of 90 per cent was easily obtained. Certain of the experiments performed in order to ascertain the preceding may be of interest.

The behavior of powdered γ Fe_2O_3 was compared with that of colloidal γ Fe_2O_3, using the type of apparatus described above but adding an extra tube in order to have similar conditions for the two compounds used. About 15 times as high a yield was obtained for the γ Fe_2O_3 powder as for the colloidal γ Fe_2O_3, although the surface of the colloidal powder is much larger. The reason for this was later found to be the following: The colloidal γ Fe_2O_3 was prepared with mineral oil as a carrying medium. The mineral oil was later removed with petrol ether and the solid colloidal γ Fe_2O_3 heated to 150° C. Traces of the oil were, however, not completely evaporated, since care was taken not to exceed the 150° C. temperature mark. This oil clogged the atomic channels and prevented the radon from penetrating within the lattice of the powder particles. Although mineral oil has, at ordinary temperatures, a strong adsorption for radon, this seems not to be the case for very low (liquid-air) temperatures, at least not in comparison with the adsorption coefficient of Fe_2O_3.

Another experiment was undertaken in order to differentiate the adsorption factors of gamma and alpha ferric oxide. In order to have the same colloidal conditions present throughout, we used the same colloidal γ Fe_2O_3, transforming half of the amount into α Fe_2O_3. This was done by heating the γ Fe_2O_3 to about 400° C., after which the powder showed only a very slight magnetic reaction, proving that at least 95 per cent of the total amount had been transformed from the gamma into the alpha modification. The

[2] Presence of radon within the powder not only would falsify the dosage required for the treatment but also might be dangerous if used in large quantities.

three-tube arrangement on our apparatus was again used to make possible a full comparison of the results. It was found that the yield in amounts of Ra B–Ra C adsorbed was from 40 to 50 per cent higher in the case of γ Fe_2O_3, calculated for equal quantities of powder. As the formation of the active deposit depends upon the adsorption of emanation (all adsorption phenomena are surface effects), this result means that the "inner surface" of the γ Fe_2O_3 powder in colloidal state is from 40 to 50 per cent greater than the surface of the alpha modification. Taking into consideration this great surface of colloidal γ Fe_2O_3, we can now understand why this material, in the colloidal state (average particle size, 0.1 μ in diameter), has such great catalytic efficiency.[3]

Application

We believe that there is no limit as to the charge of Ra B–Ra C that may be applied with the colloidal γ Fe_2O_3. The quantity of Ra B–Ra C desired can be easily obtained, depending only upon the initial quantity of Ra emanation used and upon the time elapsing between the discarding of the emanation from the powder and its injection into the blood stream. In order that the powder may have sufficient activity when used for injection therapy, it may remain in contact with the emanation until the last moment and so may be shipped to distant places if the part of the apparatus containing the powder is kept at a low temperature by either liquid air (in a thermos flask) or dry ice (solidified CO_2). It was found that when dry ice ($-60°$ C.) is used, approximately 50 per cent of the emanation may be fixed to the powder. The quantity of Ra B–Ra C to be used in the treatment may be calculated in advance as long as the initial quantities of radon, the time of storage in the apparatus or shipping, and the time elapsed between the opening of the apparatus and the application of the powder are known, so that an exact dosage is possible at all times.

An important advantage of colloidal γ Fe_2O_3 lies in the fact that it may be suspended in an aqueous medium and so be used for intravenous injections. The activated iron oxide powder is an alpha, beta, and gamma radiator; injected into the blood stream, it enters (as already mentioned) the reticulo-endothelial cells. The alpha particles emitted by the powder will be absorbed, almost entirely within the cells, all the energy being transmitted to the cells. The amount of beta and, especially, gamma radiation absorbed in the same cells is negligible in comparison with the alpha radiation. Not even 1 per cent of the ions formed in the cells will be due to beta radiation; and the number of ions produced by gamma radiation is only about 0.01 per cent of those produced by alpha particles. For that reason we can suppose that within the cells only the alpha radiation is biologically active; the tissue near the cells will receive beta radiation, while the action of the gamma radiation is spread over the entire body. Because of the strong and concentrated action of the alpha particles, however, we can limit the intensity of our preparations to very low values, so that the effect of beta and gamma radiation is of no importance.

If using preparations of 1 mc. (Ra B and Ra C), we have within the cells, by alpha action, ionization effects which with the common Ra therapy could be produced only with a preparation of 10 grams of Ra.

It is to be presumed that the highly activated reticulo-endothelial cells will be more effective in their action against bacteria and inflammatory diseases. These cells are distributed throughout the body, but are found especially in organs connected with the blood formation.

Leblond and Lacassagne (*3*), using subcutaneous injections of polonium in experiments with rats, proved by autographic methods the presence of polonium within reticulo-endothelial cells upon the lymphatic formations and also found a pronounced effect upon the lymphatic system. They recommend the use of polonium for the treatment of lymphatic leukemia. However, since polonium is toxic and produces gastric ulcerations, it would be desirable to replace it by activated γ Fe_2O_3, as described above. The use of the colloidal gamma iron oxide activated with Ra B and Ra C is preferable even to artificial radioactive gamma iron oxide (beta radiator), since in the latter case relatively high activities have to be used in order to produce the same intracellular effects; also, artificially radioactive iron has a relatively long life (47 days half-time), so that strong sources may be dangerous. On the other hand, in the case of activation with Ra B and Ra C, no dangerous after-effects have to be considered. One-tenth mc. of Ra B, after its complete decay, forms 2.5×10^{-6} mc. of polonium, if none is eliminated, so that even if we repeat the treatment from 10 to 20 times, we are still far below the amount of polonium formed by 0.1 μg. of Ra, the generally accepted tolerance dose.

It may, however, be even more advantageous to use, instead of Ra B–RaC, the active deposit of thorium, Th B and Th C. Th B has a longer life (10.6 hours half-time), and Th C also is the last radioactive element produced in this series, as Th D is already a stable element.

[3] We want to point out that this method is probably the simplest and most exact for the determination of grain sizes. Comparing it with the diffusion method, we find that we have no correction factors that may multiply any potential errors. The real surface of the powder, or grains, is simply given by the activity of the powder in comparison with that of the cooled glass tube, the surface of which can easily be measured.

In this connection it is interesting to refer to a recent paper of Kelsall (*2*), who emphasizes the relationship between lymphocytosis and cancer. If we reduce by a radiotherapeutic method the number of circulating lymphocytes, there is some hope to reduce also the growth and occurrence of tumors.

The activated gamma iron oxide (Ra B–Ra C or Th B–Th C) is interesting not only for therapeutic use but also from a biological point of view.[4] We could, for instance, follow from the outside the distribution of the activated iron oxide with a Geiger counter while trying, by means of a strong magnetic field, to influence the path of the activated magnetic cells (*1*).

Finally, using the method described by Rous (*5*) for separating Kupffer's cells by magnetic methods, the way would be open to a study of the influence of alpha particles on living cells.

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The Age Factor in Adaptability of a Sarcoma Virus to Other Animal Species

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An indispensable condition for the adaptation of avian sarcoma viruses to alien species of birds is the youth of the individual in which infection is attempted, this culminating in the case of ducks, which respond to the inoculation of viruses of the Rous and Fuginami sarcomata for only 24 hours after hatching (*3, 4*). The results that follow show that the age of the chicken bearing the tumor is also a factor of importance in determining the adaptation of the virus of the Rous sarcoma to ducks.

[4] An interesting paper on this topic was published by Maxfield and Mortensen (*J. appl. Phys.*, 1941, **12**, 197), who used, in experiments with rats, colloidal thorium dioxide. They found, by radioactive measurements, that six to eight hours after an intravenous injection, 99 per cent of the thorium was removed from the blood stream by the phagocytic action of the reticulo-endothelial cells. They recommend the use of this method for tests of the various theories of phagocytosis. However, using this method on man may be dangerous because of the aftereffects that are due to the long-life, daughter-product, mesothorium.

The experiments consisted of the inoculation into the breast of newborn ducks of cell suspensions from tumors grown in chickens varying in age from 15 days to 18 months, and of analogous inoculations into successive groups of ducklings of the tumors obtained in the preceding passages at intervals of from 1 to 3 weeks. In some cases, additional ducklings were injected in the vein with tumor filtrates, and the growths ("late tumors") that evolved several months thereafter were transferred to other groups of ducklings by means of cell suspensions.

The following results were obtained:

(1) The tumors grown in chicks from 2 to 4 weeks of age were very easily transferable into ducklings in 16 out of 17 lines, each started from a different chick tumor. Growth was fast, and the hosts often died although the tumors never became generalized. Transplantation of these tumors was successful, although irregularly, for a number of passages which, however, never exceeded 6, and always in the absence of generalization. The number of ducks developing tumors became progressively smaller in the course of the passages until none of the animals responded. The tumors in the surviving birds regressed in every case, and as a result, all the lines were lost, despite the fact that a total of nearly 350 ducklings were inoculated. Despite its long sojourn in a foreign species the virus did not show detectable signs of variation, since filtrates from the duck-grown tumors produced the customary lesions at the usual rate in chicks.

(2) The tumors grown in chickens 18 months of age did poorly in ducklings for in 6 of the 8 lines started, growth followed in only 3 out of 47 birds injected, and these two tumors could not be carried beyond a second passage. However, in the two other lines growth followed in 8 of the 11 ducklings injected, and adaptation was achieved after some passages with the customary succession of events accompanying the phenomenon.

(3) The tumors grown in chickens intermediate in age between the two above groups seemed to be the most adaptable to ducks. Most of the chickens of this group were from 5 to 10 months old, while another also supplying an adaptable tumor was 3 months old. Of the 6 duck-tumor lines which have been obtained, 4 were evolved by passages of cell suspensions, while in the other 2 cases ducklings were successfully injected with both cell suspensions and filtrates, but the lines were obtained by passages of the "late" tumors induced by filtrates. To these cases one has to add at least 3 more in which filtrates induced typical "late" tumors, but neither these growths nor those produced by cell suspensions were passed into other ducks. However, adaptation was not

achieved with another 6 tumors grown in chickens from 5 to 8 months old.

The signs of adaptation of the chicken tumor to ducks are quite obvious: progressive growth often followed by generalization in ducks of all ages, acquisition of new tissue affinities, total or partial loss of the power to induce tumors in adult chickens, and gross and microscopic changes in the tumors (*3*). Proper analysis revealed that no two of the variants are identical, each differing from the rest in degree of generalization, incidence of non-neoplastic (hemorrhagic) or neoplastic lesions, cell type and texture of the growths, and virulence and tissue affinities of the virus inductor. In regard to the last property special mention must be made of a neurotropic strain of sarcoma which induces in the central nervous system of young ducks a typical hemorrhagic disease, while the nervous tissue of older ducks is never affected by either hemorrhagic or neoplastic lesions. Also, some of the lines have been transmitted to full-grown pigeons, in several passages, by means of cell suspensions and filtrates. Large primary tumors followed by widespread generalization have often been obtained.

The above results have to be related to the diminishing susceptibility of aging birds to tumor viruses, which finds an expression in the progressive development of a suppressing power by the blood serum against these viruses (*1, 7*). When chickens ranging in age from embryos to 2 years are infected with the virus of the Rous sarcoma, the following lesions are observed to develop: (a) a non-neoplastic, hemorrhagic disease (*2*); (b) fast-growing tumors, first combined with, and later free of, hemorrhagic lesions (*1*); (c) moderately-growing tumors (*1*); and (d) slow-growing tumors which frequently regressed (*6*). Free virus can easily be demonstrated in filtrates from hemorrhagic lesions and fast-growing tumors, whereas it is only occasionally shown in filtrates from tumors grown in old chickens (*6*). Also, study of a series of 14 spontaneous chicken sarcomata suggests that these neoplasms cannot be transplanted if they arose in old chickens (*5*).

Therefore, chicken tumor viruses infecting a progressively older individual shift from a highly favorable to a highly unfavorable medium. The present experiments suggest that adaptation to a foreign species, the duck, takes place most easily between these two extremes when presumably conditions in the medium become adverse but without reaching as yet that phase in most old animals where the effect on the virus may go as far as complete suppression and causing the tumor to regress. The process may be compared to variation in bacteria in old cultures or in convalescents. It is not that the tumor virus varies as a consequence of the infection of the duck, but rather that ducks are infected by an easily adaptable virus because that virus has previously varied in the chicken.

Finally, the fact that the tumor virus from chicks failed to vary in ducks, despite successful growth in the latter host for several passages is in itself the ideal control, proving that the lines of duck tumors were evolved by variation of the chicken virus and not by activation of hypothetical dormant duck viruses.

Summary

The age of the chicken in which the Rous sarcoma is grown has an influence on the variation and subsequent adaptation of the causative virus to ducks. Adaptation is relatively easy to accomplish when the tumor has been grown in adult chickens several months of age. It has never been accomplished when the tumor has been grown in chicks and only occasionally when it has been grown in old chickens.

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The Effects of Sex Hormones on the Copulatory Behavior of Senile White Rats[1]

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There is a large body of literature covering the experimental work on various aspects of sex activity. However, most of the behavioral studies are limited to the period of growth and early maturity. This is especially true of such studies as those dealing with the influence of the estrogens and androgens.

The present investigation is concerned with the effects of hormonal action on animals of relatively advanced age. Twenty-five male white rats, 28 months old, were used. The rats were very large, the average weight being 342.0 grams. They were derived from four litters and were divided into groups according to

[1] Thanks are due to the Schering Corporation for supplying 380 mg. of oreton (testosterone propionate) and 450 Cartland Nelson units of anteron (pituitary-like hormone from pregnant mares' serum). Thanks are also due to Parke Davis and Company for supplying 100,000 I.U. of the estrogen compound, theelin.

the split-litter technique. The 25 animals were arranged into three groups, as indicated in Table 1. A well-balanced diet was supplied, consisting of Purina products (Growena mash, Dog Chow pellets) and a plentiful supply of fresh lettuce. Each animal in the testosterone group was given daily subcutaneous injections of 1.25 mg. of the hormone in sesame oil for a period of 15 days. Each animal of the anteron group was give 5 Cartland Nelson units in tricresol solution every third day for a like period, or 25 units in all. The animals in the control group were given either sesame oil or tricresol solution, in amounts equal to the dosage allotted to the two experimental groups. Since the nature of the control injection had no effect on copulatory behavior, the control group will be considered as a unit.

TABLE 1

COPULATION SCORES FOR THE THREE GROUPS, ON THE 8TH AND 15TH DAYS

Control Group			Testosterone Group			Anteron Group		
Rat No.	8th day	15th day	Rat No.	8th day	15th day	Rat No.	8th day	15th day
1	0	7	9	14	21	17	18	17
2	0	0	10	11	17	18	13	17
3	0	0	11	11	15	19	10	18
4	0	0	12	9	17	20	8	13
5	0	0	13	4	15	21	6	7
6	0	0	14	0	14	22	4	11
7	2	0	15	0	0	23	4	7
8	3	0	16	0	0	24	0	0
						25	0	0
Av.	0.625	0.875		6.125	11.625		7.00	10.00

In the copulatory tests, each rat was exposed individually to a female in heat for a period of 10 minutes. These tests were conducted between 11:00 P.M. and 2:00 A.M., with low illumination, to ensure maximum activity. Females, as incentive animals, were kept continually in heat by giving them daily subcutaneous injections of 666 I.U. of estrogen compound (theelin). A strict criterion of copulatory activity was employed. This required that the usual pattern of rapid lumbosacral anterior-posterior oscillations, followed by licking of the penis, occur in each instance.

The main results for both copulation tests are shown in Table 1. As will be seen, only three animals of the control group exhibited copulatory behavior, and each of these only on one or another of the tests. The two experimental groups gave a fairly high average copulation score, although two of the animals of each group did not copulate at all. The difference between each of the two experimental groups and the control group is statistically significant, whereas the difference between the two experimental groups is not.

It is clear from these results that rather large doses of testosterone propionate are no more effective than the pituitary-like hormone as here employed. In the case of the latter, we must assume that the hormone operated as an activator on the interstitial cells of the testes. This interpretation seems necessary, in spite of the fact that anteron is regarded as primarily an activator for spermatogenic functions. This view is also supported by the histological findings that the interstitial cells of this group showed hypertrophy and hyperplasia in most cases. The testosterone group, on the other hand, showed some degree of atrophy at the various stages of spermatogenesis as well as atrophy of the interstitial cells with replacement fibrosis. These results would seem to raise a question as to the advisability of using testosterone propionate in replacement therapy, as is common in clinical practice. A more detailed account of this experiment may be found in another connection (*1*).

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Scanning Science—

Near the beginning of last year, a discovery was made that excited great interest throughout the scientific world, when it was announced that remains of a veritable missing link between man and the higher apes had been found in Java, in strata of Pleistocene age. The discovery was made by Dr. Eugene Dubois, a surgeon in the Dutch army, who had been stationed in Java for several years and had devoted much time to the vertebrate fossils of that island. . . .

The facts relating to the discovery itself and the position in which the remains were found, as stated by Dubois in his paper, together with some additional details given to me personally, convinced me that, in all probability, the various remains attributed to *Pithecanthropus* pertained to one individual. Under the circumstances, no paleontologist who has had experience in collecting vertebrate fossils would hesitate to place them together. . . .

The tooth, skull and femur, were found at different times in the same horizon, all imbedded in the same volcanic tufa. The tooth was found first, in September, 1891, about a meter below the water level during the dry season, and 12 or 15 meters below the plain in which the river had cut its bed. A month later, the skull was discovered, only a meter distant from the place where the tooth lay. In August, 1892, the femur also was found, about 15 meters distant from the locality where the other specimens were imbedded. Later, in October of the same year, a second molar was obtained at a distance of not more than three meters from where the skull-cap was found, and in the direction of the place where the femur was dug out. . . .—O. C. Marsh

—29 May 1896

Obituary

Forrest Rhinehart Immer
1899-1946

Forrest Rhinehart Immer, associate director of the Minnesota Experiment Station and professor of agronomy and plant genetics at the University of Minnesota, died suddenly on 2 February 1946 as a result of a heart attack.

Dr. Immer was born at Spencer, Iowa, on 18 July 1899. While a small boy, he moved with his family to a farm near Jeffers, Minnesota. After graduation from high school in 1917, he entered the service for a few months during World War I. He then entered the University of Minnesota and received his B.S. degree in 1924, his M.S. degree in 1925, and his Ph.D. in 1927.

Dr. Immer served as instructor of plant genetics in the University of Minnesota from 1927 to 1929 and as assistant plant geneticist during 1929–30. He then became associate geneticist with the Division of Sugar Plant Investigations of the U. S. Department of Agriculture, serving in this capacity from 1930 to 1935, with headquarters in the Division of Agronomy and Plant Genetics of the Minnesota Agricultural Experiment Station. During this same period he acted as adviser in statistics in the Experiment Station. Soon after accepting this position he was appointed a Fellow of the National Research Council for the year 1930–31 and spent this time in England and Sweden, studying statistics at the Rothamsted Experiment Station, England, under the direction of R. A. Fisher, and plant breeding at the Svalöf Plant Breeding Station, Sweden. In 1935 he rejoined the University of Minnesota as associate professor in the Division of Agronomy and Plant Genetics and occupied this position until 1937, when he was made a full professor. In addition to his duties as professor of agronomy and plant genetics, he was appointed vice-director of the Minnesota Experiment Station in 1941 and became associate director in 1942, in which capacity he served until his death.

One of Dr. Immer's major contributions to science was as a joint author with H. K. Hayes of a book entitled *Methods of plant breeding,* published in 1942.

Another of Dr. Immer's chief contributions was through his students. In recent years, with his added administrative duties, he continued to teach a course in Applied Statistics. His enthusiasm in science and especially in genetics and applied statistics, his fund of information in many fields, and his ever-readiness to help his students attracted an increasing number of students to his classes and made him an inspiring teacher.

Dr. Immer was called for special duty in England, in 1944, as operations analyst with the Eighth Air Force. Here he was assigned to the Operations Analysis Section, whose duty it was to analyze bombing operations and improve bombing accuracy. For his exemplary service he received citations from Gen. H. H. Arnold and Lt. Gen. J. H. Doolittle.

Dr. Immer returned to his position at the University of Minnesota in November 1944. In his administrative position he was rapidly gaining recognition and assuming leadership in the solution of agricultural problems and was serving as chairman of the Committee on Farm Structures and on Poultry Breeding set up by the directors of the North Central Regional Experiment Stations. He was also chairman of a committee on legislation relating to farm structures for the Association of Land Grant Colleges. He was very active in the American Society of Agronomy, serving on various committees, and was consulting editor in statistics for the journal at the time of his death.

H. K. Hayes
Division of Agronomy and Plant Genetics
University of Minnesota

Homer Jay Wheeler
1861-1945

Homer Jay Wheeler died on 18 November 1945 in the Mountainside Hospital, Montclair, New Jersey. He was born to Quakers, Jesse B. and Martha (Sykes) Wheeler, in Bolton, Massachusetts, on 2 September 1861.

Upon graduation from Massachusetts Agricultural College in 1883, Wheeler was offered a position as assistant to Dr. Goessmann, who had just been made director of the newly established Massachusetts Agricultural Experiment Station. He accepted the offer and served the Station for four years, thus gaining the unique distinction of having actually performed the first chemical analytical work done there.

Through the influence of Dr. Goessmann, and the generosity and confidence of a friend who loaned him sufficient funds to make the venture possible, he departed from New York for Germany in the summer of 1887 to study for his Ph.D. degree at the University of Goettingen. During his two years at the University he studied under Profs. Victor Meyer, Tollens, Henneberg, and Von Koenen. While there, together

with a small group of American students, he heard the first lectures ever given on "The Operation of the Respiration Calorimeter" (Dr. Pfeiffer). Upon being awarded the M.A. and Ph.D. degrees in 1889 he returned to the United States to assume the duties of chief chemist of the newly established Rhode Island Agricultural Experiment Station at Kingston, Rhode Island. On 15 May 1891 he was married in Brooklyn, New York, to Frieda H. F. Ruprecht of Goettingen, Germany.

It was not long before his work in connection with soil acidity, and particularly in pointing out the occurrence of an injurious degree of acidity even in many well-drained upland soils in this country, began to gain him not only national but also international recognition. Concurrently he worked on the effect of soil acidity in lessening the danger from potato scab, on the fertilizing value of sodium salts for certain crops, especially where there was a deficiency of potash, and on many similar agricultural problems. Not long after his arrival at the Rhode Island Agricultural Experiment Station he was offered the position of professor of geology in the State College, which position he filled concurrently with his Experiment Station work from 1894 to 1912. During the period from 1902 to 1903 he served similarly as professor of agricultural chemistry and from 1902 to 1912 as professor of agronomy. In 1902 he accepted the directorship of the Experiment Station and held this position until 1912, when he resigned to become manager of the Agricultural Service Bureau of the American Agricultural Chemical Company. In the interim he had made a visit to Europe to study work being done there; he had served in 1902 and 1903 as acting president of the Rhode Island State College; he was author and co-author of a great many bulletins and reports issued by the Station; he was author of the book, *Manures and fertilizers* (Macmillan); he had served as president of the Association of Official Agricultural Chemists of the United States, as president of the American Society of Agronomy, and as chairman of the New England Section of the American Chemical Society. In 1912 Brown University conferred upon him the honorary degree of Sc.D.

During his first 16 years with the American Agricultural Chemical Company, Dr. Wheeler was located in Boston. In 1928 he was transferred to the new headquarters in New York City. While manager of the Agricultural Service Bureau, he wrote and had published many bulletins, booklets, and circulars on various agricultural subjects; he conducted experiments with fertilizers in practically all of the eastern states from Maine to Florida, and as far West as the Upper Michigan Peninsula, Wisconsin, and Minnesota. He also conducted experiments with radioactive substances, with manganese, boron, and such other elements as had been claimed or purported to be beneficial to plant growth. During World War I he served as chairman of the Committee on Soils and Fertilizers of the National Research Council.

In 1933 his Alma Mater conferred upon him the honorary degree of Sc.D.

Up to five weeks before his death, Dr. Wheeler maintained a keen and active interest in all fields of chemical development and particularly in the field of agricultural chemistry. His interest in research dated from the time when in Germany he produced the first wood sugar, xylose, from beech wood, and jute.

CARL O. J. WHEELER

25 Outlook Place, Glen Ridge, New Jersey

News and Notes

The American Physical Society held its 272nd meeting at the University of Chicago 20–22 June. Two other meetings are scheduled for the summer months, one at the University of California at Berkeley, 12–13 July, and the other in New York City 19–21 September.

Some confusion surrounded the early plans of the meeting because security releases were slow in coming; nevertheless 97 papers were read during the three days in addition to the longer lectures prepared by invitation.

On Thursday morning there were three such lectures scheduled, E. U. Condon, president of the Society, presiding. E. Fermi spoke on "Elementary Pile Theory," R. F. Christy on "The Small Enriched Reactor at Los Alamos," Gregory Breit on "Theory of Nuclear Reactions."

L. A. DuBridge, vice president of the Society and president-elect of the California Institute of Technology, presided in the afternoon session which heard Farrington Daniels on "Problems and Plans of Nucleonics Research," J. R. Dunning on "Neutron Spectroscopy," and H. H. Goldsmith on "A Critical Survey of Neutron Cross Sections."

At the dinner session on Thursday night A. H. Compton spoke on "Physics Research and Release of Nuclear Energy."

Saturday, G. T. Seaborg described the "Transuranium Elements" while E. P. Wigner, Princeton, lectured on "Introduction to Theoretical Papers from Clinton."

On 4 June Rep. Emanuel Celler, New York, introduced a bill into the House calling for the establishment of a National Science Foundation. This bill, H.R. 6672, is the companion legislation to S. 1850. It has been referred to the Subcommittee on Public Health of the Interstate and Foreign Commerce Committee, which still has H.R. 6448. Since S. 1850 is awaiting passage by the Senate, the contest is now between H.R. 6448 and the new bill, H.R. 6672.

About People

Richard C. Darnell, consulting engineer on instrument design and application and president of the Washington Instrument Society, has been appointed by the Department of State, under its cultural cooperation program, to serve in China as a specialist in scientific instruments and laboratory equipment. Mr. Darnell will assist in the selection of modern scientific instruments needed to replace those worn out or looted from universities and research organizations.

John A. Fleming, who retires on 30 June as director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, will be temporarily located at the Carnegie Institution's Office of Administration, 1530 P Street, N. W., Washington 5, D. C., as adviser to the Institution in governmental and international scientific relations. As announced in *Science* on 12 April, Merle A. Tuve becomes the new head of the Department on 1 July.

Robert S. Harris, director of the Nutritional Biochemistry Laboratories at Massachusetts Institute of Technology, has been promoted to professor of biochemistry of nutrition in the Department of Food Technology.

Forrest F. Cleveland, professor of physics and director of spectroscopy research at Illinois Institute of Technology, Chicago, will return on 1 July to his former position as head of the Departments of Physics and Mathematics at Lynchburg College, Virginia.

Felix G. Gustafson, professor of botany, University of Michigan, has been invited by the Ministry of Agriculture of Brazil to give a lecture course in plant physiology in the Graduate School at the Universidade Rural, Rio de Janeiro, during the months July to September. He will also give a few lectures on recent researches in plant physiology.

A. C. Trowbridge, state geologist of Iowa and head of the Department of Geology at the State University of Iowa, and L. L. Ray, geologist with the U. S. Geological Survey, will attend an excursion to central Norway in late June and early July. The excursion, under the auspices of the Norsk Geologisk Forening, will examine phenomena connected with the retreat of the last ice sheet, and geomorphology. K. M. Strøm is the leader of the excursion.

Lt. Col. Gustave J. Dammin, Medical Corps, in June leaves the Office of The Surgeon General, where he has been chief of the Laboratories Branch since January 1945 to join the staff of the Department of Pathology at The Johns Hopkins Medical School. Col. Dammin was awarded the Legion of Merit for his work in the Laboratories Branch and as a member of the Dysentery Commission in India, and has recently returned from Europe, where he was a member of the Influenza Mission.

Alexander Silverman, head of the Department of Chemistry of the University of Pittsburgh, addressed the Western Maryland Section of the American Chemical Society in Cumberland, 24 May, on "Glass: Retrospect and Prospect."

Erwin Raisz, of the Institute of Geographical Exploration, Harvard University, gave the annual lecture on 18 May before the University of Cincinnati Chapter of Sigma Xi, speaking on "Maps: Their Past, Present, and Future."

Luther S. West, chief of Natural Sciences and head of the Department of Biology, Northern Michigan College of Education, Marquette, has been awarded the Army Commendation Ribbon for his work in entomology in the Army Medical School.

Croom Beatty, III, has resigned as director of the Organic Research Laboratory of the Sprague Electric Company, effective 1 July 1946, to accept an appointment as assistant professor of chemistry at Purdue University, West Lafayette, Indiana.

Perry J. Melnick has been appointed associate professor of pathology at the University of Southern California Medical School. Dr. Melnick was released from active duty as a lieutenant colonel in the Medical Corps in April.

Announcements

The Air Surgeon announces the development of a hydraulic artificial leg at the Army Air Forces Aero Medical Laboratory in Heidelberg, Germany. Two German scientists, Ulrich K. Henschke and Hans A. Mauch, working in this Laboratory, have invented a device consisting of a small cylinder filled with hydraulic fluid and a piston connected with the upper leg. The movement of the piston is controlled by a

valve which can be opened or closed at will with the abdominal muscles, by means of an ingenious belt.

The hydraulic element can be installed in present artificial legs.

Principal advantages are the control of knee flexion and the ability to lock the knee in various degrees of flexion; these are considered to be considerable advances in prostheses. The development will shortly be turned over to Surgeon General Kirk and his Research Protheses Laboratory for further exploitation.

The Physics Department of the University of California, Los Angeles, announces the following promotions in rank and new appointments: L. P. Delsasso and Norman A. Watson have been promoted to associate professorships. J. R. Richardson has been appointed associate professor, and Byron Wright and Bernard Peters have been appointed assistant professors. The last three men will be responsible for the inauguration of a program in nuclear physics. The original 37-inch cyclotron is to be transferred from Berkeley to the Los Angeles campus and will be operated as a frequency modulated cyclotron.

The sentence imposed upon Alan Nunn May by the British Government has been strongly criticized by the Executive Committee of the Association of Scientific Workers of Great Britain in a communication directed to the American Association of Scientific Workers in the United States. The British Association does not seek to justify Dr. May's breach of the Official Secrets Act, but feels that the sentence of 10 years penal servitude is out of proportion to the offense in view of the following facts: The maximum sentence in the proposed British Atomic Energy Bill is only five years penal servitude; less severe sentences have been imposed upon persons who had actively aided the enemy; the person to whom Dr. May gave unauthorized information was a representative of an allied government; little consideration seems to have been taken of Dr. May's positive contribution to atomic bomb research; Dr. May was in a position to give fundamental scientific information only, having had no connection with the "know-how" of atomic bomb manufacture.

The Association believes that full freedom in the interchange of scientific knowledge is essential both for scientific progress and international cooperation. The report also expresses the opinion that the original decision to undertake the development of atomic energy without the closest cooperation with the Soviet Union was a hindrance to, and has largely contributed to the present unfortunate situation in, international relations.

Two fellowships for the study of rheumatic fever are available to recognized institutions concerned with the study of rheumatic fever and rheumatic heart disease, according to the American Council on Rheumatic Fever of the American Heart Association. Each fellowship is for a period of three years and carries a stipend of $3,500, $4,000, and $5,000 for the first, second, and third years, respectively.

These fellowships are provided by the American Legion and its Women's Auxiliary as part of their program of fostering research in rheumatic fever and rheumatic heart disease.

Applications supplying information concerning the institution, the projected study, and the individual proposed for the fellowship will be accepted until 1 August, to be effective 1 September, and should be addressed to the American Council on Rheumatic Fever, American Heart Association, 1790 Broadway, New York 19, New York.

The National Mental Health Act, the Priest Bill (S. 1160 and H.R. 4512), has been endorsed by the Public Health Relations Committee of the New York Academy of Medicine, on behalf of the Academy. This measure provides for the establishment of a national psychiatric institute and allocates the sum of $10,000,000 per annum to provide grants-in-aid to universities, hospitals, laboratories, and other public institutions and to individuals for research projects in the field of psychiatry.

The Committee has expressed the view that the studies should be directed toward the early detection of these disturbances, their prevention, and a more practical and shorter form of therapy. The opinion was also expressed that the institution should be placed near an urban center within easy reach of clinical material and interchange with other scientific organizations. The Academy feels that too great a size and too rapid a turnover will preclude a careful follow-up system among in-patients. It was also recommended that the compensation should be adequate enough and the selection and training of personnel scrupulous enough to achieve the highest degree of competence on the staff of the institution. It is further hoped that the program will encourage more adequate psychiatric training within the medical schools.

The Van Eseltine collection of Carex has been transferred from Keuka College, New York, to Cornell University. Started in 1913 while the late Glen Van Eseltine was at the Smithsonian Institution, this collection grew to nearly 1,400 sheets over a period of 25 years. In 1938 the Van Eseltine herbarium of about 5,000 specimens, all carefully preserved, mounted, and labeled, was presented to Keuka College. Since it was felt that the Carex genus was not of

sufficient interest to students in a small college, arrangements were made to transfer it to Cornell University, where it could be put to fuller use. The remainder of the herbarium is retained at Keuka College.—*Hazel R. Ellis* (Keuka College).

Recent Deaths

John C. Hoyt, 72, died 21 June at his summer home at Paris, Virginia. He had been a member of the U. S. Geological Survey for twenty years and in government service for 49 years prior to his retirement in 1944.

Philippe Lasseur, 63, professor of microbiology in the Faculté de Pharmacie, Université de Nancy, died on 10 January 1946 from complications following an attack of pneumonia. Dr. Lasseur is best known for his studies on the conditions affecting growth and pigment production by dissociated types of various species of chromogenic bacteria. In 1928 he founded the annual publication, *Travaux du laboratoire de microbiology de la faculté de pharmacie de Nancy,* in which most of his later work was published. Despite the difficulties of the war, he was able to continue work and the publication of this journal, of which Fascicule 14 appeared in 1945.

Harry Waldo Norris, 83, professor emeritus of zoology at Grinnell College, Iowa, died on 15 January.

Hellen Elisabeth Ramsdell (Mrs. Noel F. Shambaugh), formerly on the faculties of Ohio State University and the University of Michigan, died at Signal Hill, California, on 23 January.

E. G. Boulenger, 57, director of the Zoological Society (London) aquarium from 1923 to 1943, died on 30 April.

The War and Biological Sciences in Japan[1]

Before the war, Japan was ahead of other Oriental countries in most fields in extent of scientific development. In the years immediately preceding the war there was a definite trend toward publishing scientific works in the Japanese language, and many finely illustrated books or comprehensive works appeared, particularly those dealing with the fauna and flora of Japan or neighboring countries.

[1] The ideas set forth in this article are those of the author and are not necessarily endorsed by the Navy Department. The information was collected by the undersigned while serving on the staff of the Commander, U. S. Fifth Fleet as assistant to Commodore M. D. Willcutts, MC, USN, Fleet Surgeon.

The biological sciences have suffered considerably in Japan as a result of the war. In general, only research of importance to the war effort was given support; nevertheless, university professors and certain scientists had some freedom, within the limitations of equipment, materials, and demands made upon their services. As a result of the confusion incident to the bombing of the Japanese homeland in the latter part of the war, much of the nonessential work virtually came to a standstill, and at the present time emphasis is being placed on increasing production of food, particularly that coming from marine and agricultural sources.

Considering the extent to which most of the cities of Japan were destroyed, a fairly high proportion of the scientific institutions received little or no damage. The Imperial University, with its branches at Tokyo, Sendai, Sapporo, Nagoya, Kyoto, Osaka, Fukuoka, Keijo, and Taihoku, lost very few buildings. None were lost in Kyoto, Sapporo, Fukuoka, Keijo, and Taihoku; only a few wooden buildings and dormitories were burned at Tokyo; and a few structures were destroyed at Sendai and Osaka. The biological laboratories and collections are still almost entirely intact.

In Tokyo, the Agriculture College, the Science College, and the Research Institute of Natural Resources were almost completely destroyed by fire, including laboratories and collections. The Imperial Agriculture Experiment Station remains intact, as do the Higher School of Agriculture and Forestry, the Sericulture Experiment Station, and the Forestry Experiment Station. Of the private ornithological museums in Tokyo, that of Marquis Yamashina is the only one still intact. Prince Takatsukasa's museum was completely destroyed. The collection of Mr. Hachisuka (formerly Marquess) is partly stored at Marquis Yamashina's museum. Marquis Kuroda's collections of birds and mammals were completely destroyed. Viscount Shibusawa's fish and anthropological collections are intact. The private entomological museums belonging to S. Hirayama and M. Kato were not destroyed, although they have been closed for many months. The Ueno Museum was likewise untouched.

Institutions in Kyoto are intact, as is the Hydrobiological Station of Kyoto Imperial University at Otsu, on Lake Biwa. In Hiroshima, the Science College and College of Agriculture and Forestry were destroyed, as was the Medical College in Nagasaki. The Marine Biological Station at Misaki was taken over and its work interrupted by the Japanese Navy. The marine stations at Asamushi (Mutsu Bay, near Aomori) and Shimoda are operating, as is the laboratory of the Nissan Marine Products Company at

Odawara. Parts of the collections or libraries of many of the institutions which were not destroyed are still displaced, having been moved out of the cities as precaution against destruction.

Relatively few scientists were among the many thousands of civilians killed during the war. In Hiroshimo, however, many members of the staff of the Science College were killed, including Prof. Hiraiwa and Asst. Prof. I. Sato, of the Zoology Department. In Nagasaki, the president, 12 of the 19 professors, 10 assistant professors, and others of the Medical College were killed.

Among the scientists who died natural deaths during the war was Asajiro Oka, who was a student of Leuckart, and introduced the theory of evolution into Japan. He was professor at Tokyo Higher Normal School and Tokyo Science College. Dr. Oka's death occurred on 2 May 1944. His son, Hidemichi Oka, is now experimental zoologist at Tokyo Science College and editor of the Zoological Magazine (*Dobutsugaku Zasshi*). Chiyomatsu Ishikawa died in Formosa in 1941 or 1942. Dr. Sasaki, of the College of Agriculture, Tokyo Imperial University, died shortly before the start of the Pacific War. Matsuji Hori and Y. Niijima, of Sapporo, and Masaki Matsushita, of Toyohara, Hokkaido, all of whom were entomologists, died during the war.

Among the specialists displaced by the war may be mentioned the following, with their respective locations at the end of the war: Ryoichi Takahashi, aphid specialist of Formosa: head of the zoological gardens, Kuala Lumpur, Malacca; Seishun Iwata, mosquito specialist of Osaka Imperial University Medical College: Kuala Lumpur; Kinji Iwanishi, mayfly specialist of the Otsu Hydrobiological Laboratory: Mongolia; Mr. Dokei and S. Kawada, entomologists of the Imperial Agriculture Experiment Station: China and Java, respectively; Isao Taki, malacologist: in charge of mollusc collections of the Academia Sinica, Nanking; Y. Yano, professional collector: Burma; H. Sawada, coleopterist: China; Kunio Iwata, hymenopterist: Hainan Island; Maj. Shinichiro Yamada, mosquito specialist, and Atsuo Tanaka, specialist in biting flies, of Kyoto Imperial University: Japanese Army, locations unknown. S. Hatai, zoologist of Sendai Imperial University, went to Manila to work at the Bureau of Science for the Japanese Army, but returned to retirement at Omori, in Tokyo, before the recapture of Manila. His son, Naoki Hatai, zoologist, was in Peking at the end of the war. Another son, Kotora Hatai, is still at Sendai Imperial University, working on fossil invertebrates. The Palau Tropical Biological Station was moved with its staff to Makassar, Celebes, and many other specialists were scattered in the "southern regions."

Some of the principal Japanese specialists are at present located as follows:

Tokyo Imperial University—N. Yatsu (retired), zoology; Y. K. Okada, experimental morphology; T. Goda, biochemistry; T. Kamada, physiology; K. Dan, embryology; K. Takewaki, internal secretions; H. Kinoshita, physiology; T. Fujii, biochemistry; K. Kikuchi, limnology (also of the Marine Biological Station, Misaki); Y. Shinoto (Sinoto), N. Tanaka, and N. Suita, plant genetics; T. Kaburaki and T. Kojima, entomology. *Botanical Gardens, Koishikawa, Tokyo*—Haruo Furukawa. *Research Institute of Natural Resources* (*Shigenkagaku Kenkyusho*), with several temporary locations in Tokyo and a laboratory near Mt. Fuji—Yaichiro Okada, vertebrate zoology (also curator of Marquis Yamashina's museum); Kiyomatsu Matsubara and Mr. Kuronuma, ichthyology; and Kenichi Nomura, entomology. *Imperial Agriculture Experiment Station, Tokyo*—Hiroshi Terao, director; Hiroharu Yuasa, Coleoptera, chief entomologist (S. Kinoshita has retired and is now insecticide specialist for a chemical firm in Saitama Prefecture); Nobumasa Yagi, flies; Masahiro Ii (Tozawa), T. Kawabe, T. Yamazaki, and Mr. Kamito, agricultural insects. *Tokyo Agriculture College*—K. Kamiya and T. Adachi, Coleoptera. *Higher School of Agriculture and Forestry*—Dr. Tei Ishii, parasitic Hymenoptera, and O. S. Shinji, aphids and gall insects. *Imperial Sericulture Experiment Station*—Juichi Kuwana (son of the late S. I. Kuwana), entomology.

Sendai Imperial University—Sanji Hozawa, termites and calcareous sponges; K. Mashiko, limnology and mosquitoes; S. Nomura, physiology; I. Motomura, experimental zoology, chairman, Biological Institute; Drs. Yamaguchi and Yoshii, botany; Dr. Tahara, plant cytology; Y. Satake, dean of the Medical College. *Agriculture Experiment Station, Omaguri, Akita*—Mutsuo Kato, entomology. *Sapporo Imperial University*—Tokuichi Uchida, parasitic Hymenoptera, head of Entomology Department (Shonen Matsumura, retired, is living in Tokyo); S. Watanabe, parasitic Hymenoptera; Hiromichi Kono, retired, Coleoptera; Kan Oguma, scale insects; Toru Uchida, coelenterates, head of Zoology Department; T. Inukai, mammalian embryology. *Kamakura Normal School*—T. Sakai (formerly of Shimoda Marine Biological Station), crabs. *Nissan Fisheries Company Laboratory*—Toshio Kumada, ichthyology.

Kyoto Imperial University—Taku Komai, genetics, head of Zoological Institute; M. Chino, genetics; T. Kawamura, birds; Prof. Miyaji, limnology; I. Honjo, physiology of senses of gnats and fleas; G. Nakada, mosquitoes; S. Yamaguchi, parasitology; Chukichi Harukawa (formerly of Ohara Agriculture Experiment Station), agricultural insects; Shunro Uchida, pea weevils and other pests; Yasuji Yamada, insects attacking wool; Dr. Kimura, bacteriology; Dr. Yamori, radiology; Dr. Ozawa, pathology. *Otsu Hydrobiological Laboratory, Kyoto Imperial University*—Prof. Miyaji, T. Kawamura; Matsuzo Ueno, aquatic flies; Masunae Tsuda, caddisflies; Mr. Uchinomi (Utinomi), invertebrates; Satojiro Kawamura,

embryology; M. Hiraguchi, anatomy; K. Yamamoto, plankton. *Kyoto City Medical College*—Shiro Kitakami and Chuai Minoura, medical flies. *Doshisha University, Kyoto*—Motoichiro Maki, herpetology. *Temporarily unemployed*—M. Tokunaga, nematocerous flies. *Private entomological museum, Yamashina, Kyoto*—Kichizo Takeuchi, sawflies. *Private entomologist, Takarazuka, Osaka*—Nobuyoshi Tozawa. *Kyushu Imperial University, Fukuoka*—Teizo Esaki, Hemiptera, head of Entomology Department; K. Yasumatsu, Hymenoptera; H. Oshima, echinoderms; K. Uchida, young marine fishes; H. Aikawa, marine crustaceans, head of Zoology Department; Dr. Narabayashi, head doctor of University Hospital. *Nagasaki Medical College*—K. Koyano, acting president.

Taihoku Imperial University, Formosa—T. Shiraki, entomologist, retired 1944; S. Isshiki, neuropteroids, head of Entomology Department; Y. Miwa and M. Chujo, Coleoptera; K. Koidzumi, insect physiology; Mr. Maki, insect morphology; Toyohi Okada, flies; Kaoru Morishita, mosquitoes; G. Masamune, plant taxonomy; S. Hibino, plant physiology. *Forestry Bureau, Taihoku*—T. Mitono, Coleoptera. *Institute for Research in Tropical Medicine*—N. Omori, mosquitoes. *Keijo Imperial University, Korea*—Harujiro Kobayashi, medical flies; K. Hori, flies.

Publication of scientific reports was greatly reduced during the war. Journals of institutions were reduced in size, and many society or private publications had been discontinued by 1943 or early 1944. Many of the books published during the war are on rather poor paper. A number of popular or semipopular scientific books were published, but few well-illustrated, high-quality texts or works on fauna or flora appeared. In general, few technical or taxonomic reports on the "southern regions" appeared, though many investigations were initiated.

Among works which appeared during or just before the war were the following: Utinomi (Uchinomi): *Bibliographica Micronesica*; Research Institute of Natural Resources: Bibliographies, covering most scientific fields of China, the Philippines, the East Indies, Indo-China, and South Pacific Islands; M. Tokunaga: *Medical entomology,* two large volumes in Japanese, well illustrated, with some color plates (1944); T. Kumada (Nissan Fisheries Company Institute): *Edible marine life of the South Pacific,* with 149 color plates, good printing, Japanese text (1941); and *Poisonous fish of the South Pacific,* with 29 plates, 27 of them in color, good quality, Japanese text (1943); Orihei S. Shinji: *Monograph of Japanese Aphididae,* 1215 pages, 579 text figures, 8 color plates, in Japanese (Tokyo, 1941); and *Galls and gall insects,* published in Tokyo by Shunyodo, with many photographic plates of poor quality, in Japanese (1944); G. Masamune: *Flora Kainantensis* (Flora of Hainan Island), (Taihoku, 1943); Umetaro Suzuki and Shizuo Momose: *Illustrated economic botany of the "southern regions,"* 193 pages, 43 plates, in Japanese (Tokyo, 1943); Hachisuka: *Birds of Hainan Island,* in English (Tori, Tokyo, 1940); Ryoichi Naito and Ryoen Kono: *Eradication of malaria-carrying mosquitoes,* 176 pages, illustrated, in Japanese (Hokuryukan, Tokyo, 1944). In 1939 Kaoru Morishita published an 82-page pamphlet, in Japanese, on Chinese *Anopheles* at Taihoku under the auspices of the Hakuaikai Hospital at Amoy, China. In 1941 Nanzaburo Omori, of the Institute for Research in Tropical Medicine, Taihoku, published an article in Japanese on the *Anopheles* of the "southern regions." In 1942 Toyohi Okada, of the Institute of Hygiene, Taihoku Imperial University, published on heleid flies in the *Transactions of the Natural History Society of Formosa.* Between 1940 and 1943 Seishun Iwata, of Osaka Imperial University Medical College, published a number of articles and pamphlets on mosquitoes, malaria, and dengue, dealing mostly with breeding habits and control of disease vectors. All are in Japanese. Yushiro Miwa published a *List of injurious insects of Formosa.* Among semipopular works recently published are: Yaichiro Okada's *Southern biology,* Furukawa's *Southern zoology,* Tamanuki's *Natural history of Saghalien,* Kunio Iwata's *Wasp stories,* Yaichiro Okada, T. Kaburaki, and others' *Natural habitats of animals,* and Yoshio Takeuchi's *Bamboos* (1940). A set of large color plates of *Birds of Greater East Asia* was published in four series, each series consisting of 5 to 6 plates which showed 8 to 12 species of birds. Among books completely destroyed in the press was Yaichiro Okada's *Freshwater fishes of Japan,* with 33 color plates.

Among more recent serial publications are Yushiro Miwa and Michio Chujo's *Catalogus Coleopterorum Japonicorum; Scientific results of the first expedition to Manchoukuo,* of which 18 volumes have already been published; and *Nihon Dobutsu Bunrui* (taxonomy of Japanese animals), of which many parts have appeared, some during the war. The newer periodicals include the *Transactions, Journal,* and *Bulletin,* all or part in English, as well as two serials in Japanese of the Research Institute of Natural Resources; *Oyokonchugaku Zasshi* (magazine of applied entomology), published at the Imperial Agriculture Experiment Station, in Japanese; *Mushi no Sekai* (the insects' world) published by S. Hirayama, Tokyo, in Japanese; and *Nippon no Kōchu* (Japanese Coleoptera), published by Kazuo Kamiya, of the Tokyo Agriculture College, largely in Japanese. Some older periodicals are *Tenthrèdo, Acta Entomologica,* in English, published by Kichizo Takeuchi, of Kyoto; *Mushi* (insects), published in various languages at Kyushu Imperial University; *The Entomological World,* mostly in Japanese, published by Masayo Kato, of Tokyo.

In scientific development and discoveries Japan, during the war, was behind the United States in many ways, although some new drugs were developed which may prove valuable. Among these are two neocyanines, called *kōha* and *shikō,* which are reputed to be helpful in the treatment of leprosy, tuberculosis, wounds, and burns. The formulas for these are given as 1,1,1″-triethyl-10-lepidyl-1-4, 4′-trimethinequinocyanine-1,1″-diiodide and 3,3′,3″,4,4′,4″-hexamethyl-

7-2′-methylthiazolyl-2,2,-trimethine-thiazolocyanine-3,-3″-diiodide, respectively. Until the end of the war, "DDT" was known to Japanese scientists only by name. As soon as the atomic bombs were dropped on Hiroshima and Nagasaki, pathologists and other specialists were sent to the areas from various institutions, particularly Kyoto and Kyushu Imperial Universities, to study effects on the victims. Many necropsies were performed and specimens taken, and, before American personnel arrived, it had been concluded that hypoplastic anemia was the principal cause of deaths occurring some time after the explosions in the case of victims who did not have serious radium burns. It was also concluded that radioactivity in the areas disappeared within several days although people entering the areas shortly after the explosions became anemic.

In general, Japanese scientists and most of the population show a great desire to develop contacts and friendly relationships with America and to increase American influence in Japan. This attitude is not as naïve as might be assumed by one not realizing the extent to which most of the Japanese people were ignorant of the actual facts about the war and how resentful they now are of the Japanese militarists who forced the country into conflict.—*J. Linsley Gressitt,* Lt. (jg), H(S), USNR (U. S. Naval Medical Research Unit No. 2, Guam, Marianas Islands).

In the Laboratory

A Useful Selective Bactericidal Property of Tergitol-7

ARTHUR L. POLLARD
Knoxville, Tennessee

In the course of isolating Streptomyces (Actinomyces) from soil on starch tryptone agar an extremely heat-resistant bacillus was found as a contaminant in the starch used. Only an Arnold sterilizer was conveniently available, and frequently this organism would remain viable after heating for 30 minutes on three successive days. In one case it remained viable after heating for 30 minutes on six successive days.

The work of Baker, Harrison, and Miller (*1*) suggested detergents as a possible means of eliminating the bacillus without inhibiting the growth of Streptomyces. After some preliminary work Tergitol-7 was selected and the following series of tests carried out. The contaminated starch was used in making up starch tryptone agar.

Test 1. Tergitol-7 was added to starch tryptone agar to make final concentrations of 0, 1:60,000, 1:40,000, 1:30,000, and 1:20,000. This was tubed in ¾ in. × 6 in. tubes to a depth of 3½ in. and the tubes sterilized in the Arnold for exactly 30 minutes. At the end of eight days the tubes with 0 concentrations showed abundant surface growth and some growth throughout the entire column of agar. None of the tubes with 1:30,000 or 1:20,000 concentrations showed growth. All the tubes with 1:60,000 showed growth, and five out of six of the 1:40,000 tubes showed limited growth. The sterile tubes containing 1:30,000 and 1:20,000 were melted and poured into Petri dishes. These were streaked with five species of Streptomyces. Normal growth was obtained on all 1:30,000 plates and on all but one of the 1:20,000 plates.

Test 2. A soil suspension to give a final concentration of 1:10,000 was added to five deep tubes of starch tryptone agar and to five tubes of the same containing 1:20,000 Tergitol-7. The tubes were then sterilized for 30 minutes in the Arnold. At the end of eight days all control tubes showed abundant surface growth and some growth at all levels. None of the tubes containing Tergitol-7 showed growth. The sterile tubes containing 1:20,000 Tergitol-7 were poured into Petri dishes and streaked with *Staphylococcus aureus, Penicillium notatum, Penicillium* spp., *Aspergillus niger,* and *A. flavipes.* All these organisms showed characteristic growth.

TABLE 1
TERGITOL-7 CONCENTRATIONS

	0	1:40,000	1:20,000	1:10,000
E. coli	xxx	xxx	xxx	xxx
Staph. aureus	xxx	xxx	xxx	0
B. subtilis	xxx	xxx	xx	0
B. mycoides	xxx	xxx	0	0
B. sp. (heat res.)	xxx	xxx	0	0

Test 3. Tergitol-7 was added to tubes of nutrient broth in concentrations of 0, 1:40,000, 1:20,000, and 1:10,000. These were sterilized in the autoclave at 15 pounds for 20 minutes. They were then infected

with *Escherichia coli, Staph. aureus, Bacillus subtilis, B. mycoides,* and the heat-resistant bacillus mentioned above. Results were as shown in Table 1.

A loopful of broth from the tubes showing no growth was then streaked on nutrient agar slants. No growth was observed on any of them. This test was repeated three times with the same result.

Test 4. Since running the above tests a large number of starch tryptone agar tubes containing 1:30,000 Tergitol-7 have been sterilized in the Arnold for 30 minutes and allowed to stand at room temperature for at least eight days before using. About 4 per cent of these have shown limited growth.

Summary

Starch tryptone agar containing 1:20,000 Tergitol-7 was successfully sterilized in the Arnold by one 30-minute heating period. Decreasing the concentration to 1:30,000 resulted in 4 per cent failures.

A concentration of 1:20,000 in the cold killed spores of *B. mycoides* and an unidentified heat-resistant bacillus but failed to kill spores of *B. subtilis.*

Concentrations of 1:30,000 permitted growth after sterilization of all species of Streptomyces which were tested, while concentrations of 1:20,000 permitted growth of all species but one.

Concentrations of 1:20,000 did not inhibit the growth of selected species of *Penicillium* and *Aspergillus* or of *Staph. aureus.*

Concentrations as high as 1:10,000 did not inhibit the growth of *E. coli.*

Reference

1. Baker, Z., Harrison, R. W., and Miller, B. F. *J. exp. Med.*, 1941, **73**, 249–271.

A Method for Continuous Parenteral Administration of Penicillin and Other Drugs

Baxter G. Noble, 1st Lt., MC

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The rapid systemic elimination of penicillin necessitates frequent and often uncomfortable injections. The method here used eliminates this disadvantage by the use of an inlying, deep subcutaneous needle connected to a syringe with automatic feed.

As shown in Fig. 1, the apparatus consists of two flashlight batteries (in series) connected, through a potentiometer, with two steel (needle) electrodes immersed in an electrolyte (3 per cent KOH). An outlet from the electrolyte bottle connects, through a rubber tube and stopper, with a rubber finger cot inside the syringe. As gas is formed, the finger cot expands, forcing out the contents of the syringe. Adjustment of the potentiometer affords control over the rate of injection. In the model employed, injection rate could be varied from 1 cc. per minute to 1 cc. per hour. To use, penicillin (100,000 units) is dissolved in 20 cc. of normal saline, loaded into the syringe, and the potentiometer adjusted to the desired rate of flow as shown by the improvised Murphy drip (usually 1 or 2 cc. per hour). The original model is compact and in its entirety can be strapped directly

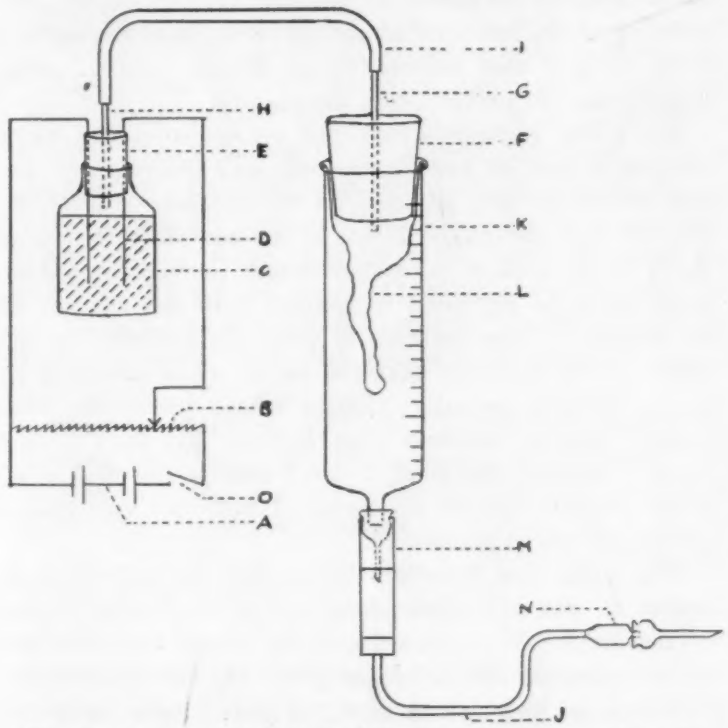

Fig. 1. A—two 1½-volt flashlight dry cells in series; B—25,000-ohm potentiometer; C—small electrolyte bottle of 3 per cent KOH; D—steel needle electrodes; E, F—rubber stoppers; G, H—hollow glass tubes; I, J—small-lumen rubber tubing; K—barrel of 20-cc. syringe; L—rubber finger cot; M—Murphy drip (size 23 needle inside a glass viewing tube); N—subcutaneous needle and adapter; O—switch.

to the leg or to an arm board, allowing relative freedom of movement; however, for more uniform injection elevation of the syringe at least two feet above the level of the patient is preferable. Battery drain is negligible, a single set of dry cells giving over 100 hours of service. The potentiometer should, however, be advanced to the full "on" position every six hours to depolarize the electrodes and prevent slowing up of electrolysis.

Continuous injection over 10- to 12-hour periods occasioned very little discomfort, though there was moderate residual tenderness that soon subsided. Only one reaction was observed, consisting of pronounced local irritation following removal of the needle and apparently caused by too rapid injection. The rate of injection should be slow enough for absorption to occur almost immediately, with minimum subcutaneous collection of fluid. The apparatus is also applicable for constant intravenous injection of penicillin and other drugs.

Letters to the Editor

Atomic Bombs and Novae

A number of people—and they are not all nonscientists—are apparently somewhat disturbed over the prospect of an atomic bomb explosion detonating the whole earth and producing a nova. When those not versed in physics have raised the question with me, I have usually explained the packing effect, stability of nuclei, and have pointed out that, while the fission of uranium releases energy, the splitting of the two most abundant elements of the earth's crust, oxygen and silicon, would absorb energy. This usually satisfies or bewilders the inquirer.

But a few physicists have put the question this way: "Granted that all our experiments and theories are correct *so far as they go, and on the laboratory scale*, do they go far enough, and can we be confident that they apply on the scale of the proposed test, in which an atomic bomb is to be exploded in contact with the surface of the ocean?" The question is naturally followed by another: "Do we know that the novae we observe out in space are not actually planets whose physicists have carried nuclear research just a little too far?" Not being a nuclear physicist, I can't answer the first question; as a student of the novae, I believe I can give a partial answer to the second.

The novae are definitely *stars*—that is, self-luminous bodies of gas with dimensions that greatly exceed those of the earth. More than a score of novae were recorded on photographs before their great explosive outbursts. After the explosions were over, the stars quieted down and assumed again (in every case for which the record is adequate) a brightness that agreed with the prenova magnitude very closely, if not exactly. Four examples of recurrent outbursts at intervals of a number of years are known. One of these stars at minimum was too faint to appear on the older photographs, but the other three show no appreciable change from one intereruption stage to the next. The explosion is evidently relatively superficial and produces no appreciable permanent alteration of the star.

Except for the recurrent novae and one other (Nova Aquilae 1918), more intimate observations of the prenova stars are not available, but the postnova stars have been well observed in about a score of cases. They are all of a perfectly distinct and unmistakable type, quite unlike "normal" stars (such as the sun). Their total brightness is similar to that of the sun, on the average, but they are much smaller than it and have much higher temperatures. Their densities must be from 100 to 1,000 times that of water; they are "subdwarfs," intermediate between "normal" stars and the very dense and small "white dwarfs."

Observations of the spectrum of a nova in the quieting-down stages of the eruption indicate pretty clearly that the outburst originated in the star and not in a satellite of it. The scale of the explosion is vast; the luminosity exceeds that of the star at its normal minimum for at least a few years, and the amount of matter erupted is in the neighborhood of 100 times the mass of the earth. Thus, a giant planet would be required, though it should be possible to observe a similar explosion of an earth-like mass if one occurred. The fact that several novae have continued to vary for many years, and that a few were variable before the outburst, is similarly definite evidence of the stellar nature of the explosion. It would be quite remarkable if every one of the too-inquisitive planets were associated with the same very peculiar type of star. And the fact of recurrence is similarly irreconcilable with the suggestion of a planetary accident.

Thus, the well-observed novae are quite conclusively in disagreement with the planetary explosion hypothesis and no other observation supports it. But of course there are a number of novae for which the observational record is so sketchy that we can only say they do not contradict the preceding statements. If the suggested catastrophe were to be admitted as a physical possibility, then I could not deny that among the *most imperfectly observed* novae some might have been produced in that way.

The above statements are not made in defense of the atomic bomb tests, but simply in answer to a question that has been raised privately enough times to make a public answer appear in order.

DEAN B. MCLAUGHLIN
Observatory of the University of Michigan

Facts, Feelings, and Freedom of Science

In his reply (*Science*, 1946, **103**, 404) to our letter "Freedom of science in the Soviet Union" (*Science*, 1946, **103**, 281), Sergei Gaposchkin, of the Harvard College Observatory, accuses that our letter "does not contain facts but only feelings."

We presented at least three facts: (1) the nonexistence of freedom of science in the Soviet Union, (2) the imprisonment and death in a concentration camp of N. I. Vavilov, and (3) the imprisonment of many other scientists in the Soviet concentration camps. We are also sure that Dr. Gaposchkin, as an astronomer, knows about the purge of Soviet astronomers in which some prominent scientists were liquidated (see R. Simpson. *Sat. Rev. Lit.*, 30 March, p. 30). But he ignores all these facts, calling them feelings, and then indulges in an emotional outburst.

What bearing on the freedom of science has, for instance, the very regrettable fact of huge Soviet losses in the last war? The Soviet Government used to imprison and execute scientists many years before the war and continues to do so. The statement that the lives of 130,000,000 Americans were saved by the Russians not only has not even the slightest connection with the subject raised by us but is very controversial, because many Americans think that the United States saved the Soviet Union. We believe the proper place to discuss all these questions injected into controversy by our opponent is

Russian newspapers and magazines and not an American scientific periodical.

As to the contention that our letter does not contribute to the friendship of the United States and the Soviet Union, we are strongly convinced that the friendship between two great nations cannot be built on the basis of misrepresentations and appeasement of tyrants. Munich showed us the futility of such a cowardly policy. The thesis that everybody who is criticizing the Soviet Government or even its certain policies is an enemy of the Russian people is well established in the USSR but not necessarily in the United States, where public opinion seems to understand that the Government and the people of the Soviet Union are not synonymous, as is the case in all totalitarian countries. It means also that the Russian people should not be held responsible for the crimes of its Government. The purpose of our letters is to stimulate public opinion against the slavery of science in the Soviet Union, because we think that the freedom of science is a prerequisite for the establishment of normal international cooperation in that field and is also a safeguard against the use of science for aggressive war purposes. We know that we cannot please everybody: the oppressors and the oppressed, the proponents and opponents of the Soviet regime. Our choice is the side of Russian people and not of its oppressors.

In conclusion, we venture to mention that even the indiscriminate use of quotation marks cannot change the fact that we never said that we do not understand the language of common Russian people. One has only to read the last sentences of our letter to see that we referred simply to the constant and persistent misuse by Soviet propagandists of such words as freedom, democracy, etc. That such practice of many years in a totalitarian country, isolated by the iron curtain from the outside world, can affect the minds of the people, especially of the younger generation, was abundantly demonstrated by Hitler and hardly can be denied. And that is why we mentioned that probably we and Dr. Zhebrak talk different languages.

VLADIMIR C. ASMOUS
Arnold Arboretum, Harvard University

On Science and Government Subsidies

The discussion in *Science* of the proposed government support of scientific research reveals that while some scientists do not seem to realize the tragic deterioration in the character of the U. S. Government, there are many practical scientists who fully comprehend the facts in the case. Thus, the letter from M. W. Welch (*Science*, 1946, **103**, 430) justly doubts the wisdom of enacting questionable legislation without surrounding it with adequate safeguards. Mr. Cohn, in the same issue (p. 430), outlines a plan for the sound administration of such an act.

However, many of us who have had actual experience in wartime government service both overseas and in Washington have become hard-boiled cynics where altruistic planning and control by the Federal Government is contemplated. Not only have we seen too much of incompetence, waste, and bureaucratic bungling, but also we have learned to question the real motives of most of the legislation publicized as being for "the public welfare." The Murray-Dingell-Wagner socialized medicine bill, the Kilgore-Magnuson bill, the national school lunch legislation, schemes for price control, anti-inflation, Federal housing, farm subsidies, atomic energy control, and what-have-you, all have as a common denominator an ulterior purpose—increasing regimentation of the American people, greater spending (and electing), and more jobs for bureaucrats. (Thus, the "public health" act would require the employment of 300,000 more jobholders.)

To place American scientific research in a bureaucratic straightjacket would greatly retard our own progress while other nations forged ahead. When and if the United States returns to its normal American form of government, crushing taxes are reduced, and restrictions and controls are removed from industry and agriculture, there will be ample surplus funds available from the incomes of generous American citizens and corporations to support sound scientific research foundations serving national needs with that independent efficiency found only among free men.

American science, which has contributed largely to making our United States the leader of the world, can continue its vital services to mankind without any additional government subsidies or supervision.

STANLEY F. MORSE
Winter Park, Florida

New Units for the Measurement of Radioactivity

In *Science*, 1946, **103**, 712, E. U. Condon and L. F. Curtiss, representing the National Bureau of Standards and at the suggestion of the Committee on Radioactivity of the National Research Council, propose a new unit to replace the curie to express the strength of radioactive sources. They choose as the new unit 1,000,000 disintegrations per second, to which they assign the name "rutherford." A microrutherford would, therefore, be one disintegration per second.

While it is true that the curie was originally adopted in 1910 by the Congress of Radiology as a standard of radon, its use was later extended to any other member of the radium series in radioactive equilibrium with one gram of radium element. Subsequently the curie has been adopted as the unit of rate of disintegration of all radioactive elements. The accepted value is 3.7×10^{10} per second. While there has been some disagreement over this value, this is in no way the fault of the unit but lies rather in the inaccuracy of its physical measurement. A gram of radium in the form of a salt can be purified and weighed with an accuracy far exceeding that of any existing method of radioactive measurement.

The adoption of a new unit will not improve the methods of measurement or enhance the accuracy of the data. Hence, if it does not give added convenience, it seems to have no advantage and will simply lead to unfortunate confusion. The fact that the magnitude of the unit is unhappily chosen may be seen by consulting the values given in terms of curies, millicuries, and micro-

curies for new fission products in Tables 1 to 6 in the same number of *Science* (pp. 700–704). In all cases the use of the new unit would give more awkward numerical expressions. The claim that the new unit is chosen so small as to avoid confusion with the curie is not an appealing one.

Finally, let me disclaim any disinclination to honor Lord Rutherford. No one could be more worthy of the highest honor in the field which he did most to create. But to name a new unit for him where one already exists seems to be superfluous and would spoil the term for future use. If there is to be a unit named for Rutherford, let it be one worthy of him.

The same authors further recommend a new unit, r.h.m. (''rum'')—one roentgen per hour at one meter from the source for intensity of gamma radiation. The convenience of such a unit is something for radiologists to decide. Both questions should be referred to the appropriate international body of which the National Research Council is a member.

S. C. Lind, *Dean*
Institute of Technology, University of Minnesota

Thyroid Adenomas in Rats Receiving Selenium

We have observed increased size, hyperplasia, and loss of colloid in the thyroid glands of 16 white rats which had received 0.05 to 0.1 per cent bis-4-acetamino-phenyl-selenium dihydroxide in their diet for 10 days. Eight white rats which had received 0.05 per cent of the selenium compound for 105 days had multiple adenomas of the thyroid glands and adenomatous hyperplasia of the liver. A detailed description of the experiments, complete pathological findings, and comparative effects of other organic and inorganic selenium compounds will appear elsewhere. Here it suffices to point out the goitrogenic action of the selenium analogue of a sulfur compound and its property of producing adenomatous changes in a relatively short time.

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George Hudyma, and George Mueller
Wyeth Institute of Applied Biochemistry
Philadelphia

Cestode "Parasitized" by Acanthocephalan

While engaged in a survey of the fisheries of Great Bear Lake, Northwest Territory, for the Fisheries Research Board of Canada, the writer observed that nearly all the lake trout, *Cristivomer namaycush* (Walbaum), were hosts to two intestinal parasites. One of these was the cestode, *Eubothrium salvelini* (Schrank), and the other the acanthocephalan, *Echinorynchus salvelini* (Linkins). Normally, both parasites were attached to the intestinal mucosa of the host, the tapeworms by their scolices and the acanthocephalans by their proboscides. A number of specimens of each were preserved for record and study. This winter an examination of the preserved tapeworms revealed that those from two different trout had some of the acanthocephalans firmly attached to their bodies. One cestode had four of them. Each acanthocephalan had buried its proboscis to the full extent in the strobila of the tapeworm. Some were attached to the sides of the cestodes and others to the ventral and dorsal surfaces. The specimens attached to the tapeworms appear similar in every respect to those which were attached to the host's gut.

Since the proboscis of the Acanthocephala is, like the scolex of a tapeworm, solely an organ of attachment and not a means of gaining nourishment, this relationship is not truly parasitism. Although attached to the tapeworm, the acanthocephalan is still parasitic on the trout, as it is from the trout that the food supply is derived.

This association of parasite and parasite probably arose when some of the acanthocephalans, arriving in the intestine of a trout, found the attachment sites preoccupied by a large number of the tapeworms. In seeking to fix themselves, they imbedded their proboscides in the only available solid objects—the tapeworms.

R. B. Miller
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Antipurpuric Action of A-Tocopherol (Vitamin E)

Stilbestrol given intramuscularly and intravenously to four dogs in doses of 10–20 mg./day quickly produced increased capillary fragility, prolonged bleeding and clotting times, and reduced platelet counts. When this dosage was continued for 14–25 days, a true purpura developed. This could end in widespread, large and small subcutaneous and visceral hemorrhages, bleeding into the body cavities, or even hemorrhagic death. These observations had been made previously by Castrodale, *et al.* (1941), and by Tyslowitz and Dingemanse (1941).

Giving these purpuric dogs testosterone propionate seemed not to be helpful; but administering synthetic α-tocopherol acetate (ephynal-Hoffman-La Roche) in oral doses of 200 mg./day quickly cured the purpuric animals, restoring platelet counts and capillary fragility to normal. If given sooner, it prevented the appearance of the frank purpuras and the blood-vascular deficiencies.

The antipurpurogenic action of vitamin E has been demonstrated to be valid for human purpuras also. Five thrombocytopenic purpura patients, one of whom had not been helped by splenectomy, had platelet counts and capillary fragility quickly restored to normal or near normal on 200–400 mg. ephynal orally per day; their clinical evidences of purpura disappeared proportionately. There was a great clinical improvement in one man having terminal purpura and aplastic anemia associated with advanced lymphosarcoma, as well as in three women who bruised readily, suffered from menorrhagia and metrorrhagia, and showed slightly reduced platelet counts.

This effect of vitamin E at the above dosage appeared in 7–14 days, but it seems that the treatment must be continued for long periods of time, if not permanently.

Floyd Skelton, Evan Shute,
H. G. Skinner, and R. A. Waud
University of Western Ontario, London, Canada

Book Reviews

Fluorochemistry: a comprehensive study embracing the theory and applications of luminescence and radiation in physicochemical science. Jack De Ment. Brooklyn, N. Y.: Chemical Publishing Co., 1945. Pp. xvii + 796. (Illustrated.) $14.50.

This book is devoted to a discussion of fluorescence and phosphorescence from both the theoretical and experimental points of view. The author's literary style is such that one receives the impression that he writes with little effort. Ordinarily this characteristic would make a book a great relief from the more ponderous efforts of some other writers, but in this case the author either has not read or has not understood the literature basic to the field, and therefore much of the book is worthless. The compilations of statements concerning fluorescence and phosphorescence such as are found in Chapters III, IV, VII, VIII, and IX may be found useful but are admittedly not complete. For example, the list of fluorescent organic substances given in Chapter III is stated to be one-tenth of a list published elsewhere.

The reviewer wishes to point out some examples of the errors made in the theoretical discussion. On pages 31 and 53 the author uses the term "quantization" as equivalent to excitation. That he really intends such usage is shown by his definition of the term on page 738. Apparently he does not realize that unexcited atoms and molecules are in definite quantized states. His unfamiliarity with the quantum theory is apparent also in his discussion of spectra. On page 58 he speaks of a $1S_{\frac{1}{2}}$ term; on pages 61 and 62 he has a weird jumble of comment about the Raman effect and atomic spectra; on pages 55 to 58 he discusses atomic spectra but seems to be unfamiliar with the standard notation. On pages 64 and 65 he attempts to discuss the Franck-Condon principle and ends up with a statement in which that principle and the effect referred to as predissociation are confused. Another confusion of ideas appears on page 91, where he undertakes to discuss the "thermodynamics of fluorescence" without distinguishing between a true equilibrium and a photostationary state.

Another objectionable feature of the book is the author's attempt to attach his name to principles which did not originate with him. For example, on page 2 he speaks of De Ment's first law of fluorescence, claiming that he stated it in 1942 as: "Before emission can occur from a luminescent system, absorption must first take place." The reviewer does not know when that statement first appeared, but he found the following in the *Encyclopedia Britannica* (11th ed., Vol. 10, p. 577): "Fluorescence is always associated with absorption, but many bodies are absorbent without showing fluorescence." His other principles and laws have the same degree of originality.

The binding of the book is poor, but it will probably last as long as is necessary. Other books costing less money are more valuable.

G. K. Rollefson

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Faune de France 44: Coléoptères bruchides et anthribides. **Adolphe Hoffmann. Paris: Paul Lechevalier, 1945. Pp. 184. (Illustrated.) 250 fr.**

This is a comprehensive manual dealing with the species of Bruchidae, Urodonidae, Anthribidae, Brentidae, and Nemonychidae which occur in France. The systematic treatment of the species of each family is preceded by a discussion of larval and adult anatomy and of the relationships and biology of the family as a whole. With the object of facilitating identification, easily seen characters, many of which are illustrated by line drawings, are employed in the keys; in addition, the adults of most species are figured. Bourgin's illustrations of the Anthribidae are especially praiseworthy. A bibliography of 46 titles, a combined generic and specific index, and an alphabetical list of food plants complete the paper.

Taxonomic changes of interest are the removal of *Urodon* from the Anthribidae to form a separate family, Urodonidae, and the transfer of Anthribidae from Rhynchophora to Phytophaga. The family Nemonychidae is considered transitional between the Curculionidae and Scolytidae, which is at variance with Van Emden's conclusions, based chiefly on larval studies, that this group belongs in, or next to, the Anthribidae.

Dr. Hoffmann retains *Bruchus* on the grounds of common usage, though recognizing that the name is unavailable under the rules of nomenclature; and this course will probably meet the approval of most entomologists. Certain other usages, however, are questionable. For example, the two distinct species, *Acanthoscelides obtectus* Say and *A. obsoletus* Say, are synonymized; the adoption (p. 124) of "itae," instead of the standard "inae" as the termination for subfamily names seems an ill-advised innovation; Araeocerus (staphylinid) should be *Araecerus* and Brenthidae, Brentidae; "*Bruchus villosus* F." (footnote, p. 83) is said to belong to *Spermophagus*, but it is not mentioned under that genus, although *villosus* was originally described from Germany and (if the locality is correct) should occur in France.

These and a few other minor obscurities and errors scarcely lessen the practical usefulness of Dr. Hoffmann's paper.

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Science and scientists in the Netherlands Indies. **Pieter Honig and Frans Verdoorn. (Eds.) New York: Board for the Netherlands Indies; G. E. Stechert, 1945. Pp. xxiv + 491. (Illustrated.) $4.00.**

The late conflict has made the world conscious of the Netherlands Indies as never before. The appearance at this time of a solid book on their science and scientists is most timely. At the same time, one is inclined to suspect propaganda in favor of the Netherlands rule. The reader, however, will find here only a remarkably broad and wholly unbiased picture of the development and status of pure and applied natural science in the area. It is, as it were, a review of the past up to the Japanese invasion, aimed to gain a vision for the future and, perhaps, to draw "some who feel that they have training and knowledge which can be used there for the good of mankind."

The book consists of over 75 original and reprinted articles, mostly in English, with a few in French or German. Some are translations from the Dutch of valuable papers not previously available to most readers. The range of subjects covered in these closely printed pages is surprising. These include: livestock and the veterinary service, mineral resources, climate, volcanology and seismology, rubber, cinchona, medicine, archaeology, anthropology, fish and fisheries, agriculture, chemistry, forestry, astronomy, zoogeography, phytogeography, soils, extraction of naval stores, paper pulp, sedimentation, botany, paleobotany, geology, hydrodynamics, and exploration. The last subject is enlarged by delightful selections from the travel books of H. O. Forbes, David Fairchild, and F. Schneider, the last in German. Among the scientists dealt with biographically are Felix Meinesz, the exponent of international cooperation through geoscience; Junghuhn, linked with cinchona culture; and Rumphius, the blind seer of Amboina. Historical accounts, some of which are in French, deal with various developments and the institutions fostering them. The dependence of the growth of natural science on political, social, and racial development is recognized in the inclusion of a reprinted article by Jan Broek which analyzes the diversity and unity in southeastern Asia and their implications for future political developments. Some of these articles deal as much with other areas as with the Netherlands Indies, and some include clear general explanations of the subject essential for the layman's background. Thus, an article on the geodesist, Meinesz, explains the differences in earth densities before discussing its measurement in the suboceanic lithosphere and its relation to mountain building and volcanism. Many of the articles are well documented with bibliographies, and a list of bibliographies on the area appears near the end. These, along with a list of prewar scientific institutions, broadly interpreted, and an address list of their staffs, renders this an invaluable reference work.

Anthologies of poetry and prose are well recognized means to enlighten busy people with the best in these fields. Here is an anthology of regional science which is worthy of many successors. It is unfortunate that the dictates of economy compel the adoption of such a compact format and the use of such small type for many parts. A more systematic arrangement of articles would have enabled the busy specialist to find more easily the material in his field, but perhaps the mixing of subjects was deliberately intended to compel the reader to at least rub elbows with adjacent fields, if not to shake hands and browse. In fact, one must be a browser in this book, for there is no index, its place being taken by a very full table of contents.

EGBERT H. WALKER
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Scientific Book Register

AULT, JAMES P., *et al. Oceanography—IV: The work of the "Carnegie" and suggestions for future scientific cruises.* (Publ. 571.) Washington, D. C.: Carnegie Institution of Washington, 1946. Pp. viii + 111. (Illustrated.) $1.50, paper; $2.00, cloth.

BACHARACH, A. L. *Science and nutrition.* (2nd ed.) London: Watts, 1945. Pp. xii + 142. 5s.

BANCROFT, FREDERIC W. (Ed.) *Surgical treatment of the nervous system.* Philadelphia: Lippincott, 1946. Pp. 534. (Illustrated.) $18.00.

BARBER, MARSHALL A. *A malariologist in many lands.* Lawrence, Kans.: Univ. Kansas Press, 1946. Pp. 158. $2.50.

COLEMAN, SATIS NORRONA BARTON. *Volcanoes new and old.* New York: John Day, 1946. Pp. 229. (Illustrated.) $3.75.

GLASSTONE, SAMUEL. *The elements of physical chemistry.* New York: D. Van Nostrand. Pp. 702. (Illustrated.) $4.50.

GRAHAM, EVARTS A. *1945 year book of general surgery.* (Practical Med. Ser.) Chicago: Year Book Publishers, 1946. Pp. 736. (Illustrated.) $3.00.

HUXLEY, ALDOUS LEONARD. *Science, liberty and peace.* New York: Harper. Pp. 86. $1.00.

KORFF, SERGE A. *Electron and nuclear counters—theory and use.* New York: D. Van Nostrand. Pp. vii + 212. $3.00.

LANTIS, MARGARET. *The social culture of the Nunivak Eskimo.* (Transactions, Vol. 35, Pt. III.) Philadelphia: American Philosophical Society, 1946. Pp. 153–323. (Illustrated.) $2.50.

LIGHT, RICHARD UPJOHN. *The progress of medical geography: a proposed atlas of diseases.* (Reprinted from *Geogr. Rev.*, 1944, **34**, 636–654.) New York: American Geographical Society.

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(3) Marine Biologist—The post involves research on one or more of the ground fishes and also some hydrography. Candidates should be able when necessary to carry out biological and hydrographical work at sea. Salary $3,000 rising by annual increments of $100 to $4,000.

All posts are non-contributary pensionable posts in the Newfoundland Civil Service. Further particulars can be obtained on request. Applications, stating age, qualifications, experience and the names of two or three references should be sent to:

The Director
Newfoundland Government Laboratory
St. John's, Newfoundland

POSITIONS OPEN

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Delhi, India

Director, National Metallurgical Laboratory

The Council of Scientific and Industrial Research invite applications for the post of Director, National Metallurgical Laboratory to be established at Jamshedpur. The work in the proposed laboratory will mainly comprise of fundamental and applied research on ferrous and non-ferrous metals and minerals with a view to develop and expand the primary and secondary metallurgical industries of the country. Candidates must possess: (1) Very high academic qualifications; (2) Outstanding published research work on metallurgy; and physics or physical-chemistry as applied to metallurgy; and (3) Practical experience of modern metallurgical processes. Preference will be given to those who have had at least 10 years administrative experience in an institution of repute or with a large industrial concern. Age not less than 45 years. The starting salary is 2,000 rupees per month with an annual increase of 100 rupees per month until the maximum salary of 2,500 rupees per month is reached (1 rupee = 30.5 cents). The Council can consider the grant of a higher salary to an exceptionally qualified candidate. The appointment will be for 5 years on a contractual basis. The incumbent selected will be eligible to the benefits of the Council's Contributory Provident Fund; the rate of his subscription being 6¼ percent, the Council contributing an equal amount. The selected candidate will not be required to join before April 1947 but if appointed he will be expected to advise on the proposed plans for the Laboratory. Canvassing in any form will be considered a disqualification. Two copies of the application, together with copies of testimonials and published papers should be sent so as to reach the Secretary, Council of Scientific and Industrial Research, The Mall, Delhi, not later than the 15th August 1946.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Delhi, India

Director, National Chemical Laboratory

The Council of Scientific and Industrial Research invite applications for the post of Director, National Chemical Laboratory to be established at Poona (India). Candidates must possess very high academic qualifications and should be first class research workers in any branch of Chemistry. They must have internationally recognized published work on fundamental or industrial research to their credit. Preference will be given to a person with at least 10 years administrative experience in an institution of repute. Age not less than 45 years. The starting salary is 2,000 rupees per month with an annual increase of 100 rupees per month until the maximum salary of 2,500 rupees per month is reached (1 rupee = 30.5 cents). The Council can consider the grant of a higher salary to an exceptionally qualified candidate. The appointment will be on a contractual basis of 5 years. The incumbent selected will be eligible to the benefits of the Council's Contributory Provident Fund; the rate of his subscription being 6¼ percent, the Council contributing an equal amount. The selected candidate will not be required to join before April 1947 but if appointed he will be expected to advise on the proposed plans for the Laboratory. Canvassing in any form will be considered a disqualification. Two copies of the application, together with copies of testimonials and published papers should be sent so as to reach the Secretary, Council of Scientific and Industrial Research, The Mall, Delhi, not later than the 15th August 1946.

POSITIONS OPEN

A Chicago medical laboratory wishes to engage for the summer months only, a bacteriologist, biochemist and psychologist (3) to aid in setting up a research program. State number of weeks available, salary and other information. Box 513, SCIENCE.

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